BACHELOR THESIS AND COLLOQUIUM
ME 141502

GENERATOR USAGE ANALYSIS AND EVALUATION ON SUCESS VICTORY XXXIV

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DOUBLE DEGREE PROGRAM OF MARINE ENGINEERING DEPARTMENT
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA 2017

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INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA 2017

VALIDATION SHEET

GENERATOR USAGE ANALYSIS AND EVALUATION ON MT SUCCESS VICTORY XXXIV 6780 DWT

BACHELOR THESIS

Submitted to Complete One of Requirement of Bachelor Engineering Degree
on
Laboratory of Marine Electrical and Automation System (MEAS)
Double Degree (S-1) in Marine Engineering Program
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopember

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DECLARATION OF HONOR

I, who signed below hereby confirm that:

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Department	:	Double Degree Program in Marine Engineering

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Surabaya, July 2017

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GENERATOR USAGE ANALYSIS AND EVALUATION ON MT SUCCESS VICTORY XXXIV 6780 DWT

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ABSTRACT

The generator is the main power supply of electricity in the ship. The generator can supply each ship's electricity consumer regarding the generator capacity and consumer requirement. Generators can provide the electrical needs of equipment requiring power on board according to their capacity. The generator which installed on the vessel has a complicated calculation phase in order to get the best efficiency on the ship MT SUCCESS VICTORY XXXIV. However, after having a long period of about 15 years and there are different factors between the State of Indonesia and Japan (the origin of shipbuilding), so the power capacity used is not the same as the first time when the ship is operated.

This thesis analyzes and evaluates the usage of the generator on the MT SUCCESS VICTORY XXXIV. In this study, observations were made on the switchboard panel inside the Engine Control Room to see the power usage in 4 conditions on the ship: sailing, maneuver, loading and unloading, and anchoring. Besides observing the usage of power., current, frequency, and voltage also recorded their outputs. The study includes load factors on each condition and cos φ on calculations which contains in the switchboard panel, also the observations on the use of continuous and intermittent loads on the power calculation table.

The results obtained are if it viewed from the load factor and cos φ, there is a different load factor reduction and power reduction. in each condition when compared with the first design the highest load factor in each condition are, 43% for sailing condition become 33,2%, 69% for maneuvering condition become 46,3%, 89,1% for loading/discharging condition become 42,75%, and 18,6% for anchoring condition became 14,6% . In addition, the highest Power capacity is 712.8 kVA and it compares with the highest power capacity in actual condition is 537.5 kVA. There is a gap in power capacity between design and actual condition *that has 175.3 kVA, this is because of many different factors such as weather, temperature, climate and different sea areas in Indonesia with Japan as a shipbuilding vessel of MT SUCCESS VICTORY XXXIV. In addition, there are unused equipment and transmutation of continuous loads and intermittent loads if the ship is in Indonesia areas because of the factors that have mentioned above.****Keywords: Generator, Load Factor, Cos Φ, Continuous Load, Intermittent Load***

ANALISA DAN EVALUASI PENGGUNAAN GENERATOR PADA MT SUCCESS VICTORY XXXIV 6780 DWT

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ABSTRAK

Generator merupakan pembangkit listrik utama yang ada di dalam kapal. Generator dapat menyediakan kebutuhan listrik kepada peralatan yang membutuhkan listrik di kapal sesuai dengan kapasitasnya. Generator yang terpasang pada kapal sudah melalui tahap perhitungan yang panjang agar mendapatkan efisiensi terbaik pada kapal MT SUCCESS VICTORY XXXIV. Namun setelah pemakaian yang cukup lama sekitar 15 tahun dan terdapat faktor-faktor yang berbeda antara Negara Indonesia dengan Jepang (asal pembuatan kapal), maka kapasitas daya yang dipakai sudah tidak sama dengan pertama kali saat kapal dioperasikan.

Pada penulisan tugas akhir ini menganalisa dan mengevaluasi tentang penggunaan generator pada kapal MT SUCCESS VICTORY XXXIV. Pada penelitian ini dilakukan pengamatan pada switchboard panel didalam Engine Control Room untuk melihat penggunaan daya pada 4 kondisi pada kapal yaitu: berlayar, maneuver, bongkar muat, dan lego jangkar. Selain mengamati penggunaan daya, arus, frekuensi, dan tegangan juga dicatat outputnya. Kajian meliputi faktor pembebanan pada tiap kondisi dan cos φ pada perhitungan yang terdapat pada panel switchboard, serta pengamatan tentang penggunaan beban kontinyu dan beban terputus-putus pada tabel perhitungan daya.

Hasil yang diperoleh adalah jika dilihat dari faktor beban dan cos φ maka terdapat penurunan faktor beban dan daya yang sangat jauh berbeda pada tiap kondisi jika dibandingkan dengan desain awal. Pada kondisi berlayar faktor bebannya adalah 43% menjadi 33,2%, pada kondisi maneuver faktor bebannya adalah 69% menjadi 46,2%, pada kondisi bongkar muat faktor bebannya adalah 89,1% menjadi 42,75%, dan pada kondisi laego jangkar faktor bebannya adalah

18,6% menjadi 14,6%. Selain itu, kapasitas daya tertinggi adalah 712.8 kVA dan dibandingkan dengan kapasitas daya sekarang adalah 537.5 kVA. Ada perbedaan daya antara desain pertama dengan kondisi sekarang sebesar 175.3 kVA. Ini dikarenakan banyak faktor yang berbeda dari segi cuaca, temperature, iklim dan area laut yang berbeda di Indonesia dengan Jepang sebagai tempat pembuatan kapal MT SUCCESS VICTORY XXXIV. Selain itu, terdapat peralatan yang tidak digunakan dan perubahan bebankontinyu dan beban teputus-putus jika kapal berada di Indonesia karena faktor-faktor yang sudah disebutkan diatas.

Kata Kunci: Generator, Faktor beban, Cos Φ, Beban Kontinyu, Beban Terputus-putus

PREFACE

All praise and gratitude author said to the presence of God Almighty, Allah SWT, who has given grace, pleasure, and His guidance so that I can finish the bachelor thesis report completely.

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Surabaya, July 2017

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CHAPTER I
INTRODUCTION

1.1 Background

Two-thirds of the Earth is sea area. The maritime industry is needed to support the State's economy. The most important thing in the maritime industry is a ship. The suitable and correctable calculation of ships arrangement can improve the efficiency of machinery, electrical, construction, and load space. The way to improve the efficiency of the electricity system is the suitable and correctable electrical arrangement to reduce the cost of purchasing equipment when all of plans on ship is ready.

The electrical system is the category of a main system on the ship because it is a system that serves to operate almost the entire performance on ships such as sailing, maneuvering, loading and discharging, and anchoring. To set the system itself (generator) normally, it is controlled by the crews of ship in the engine control room, but now it is already automated for using automation systems on ships.

The Generator is a major source of the electrical system of the ship. Ships need a generator which is paralleled with another generator to give power a variety of required equipment with the amount of load that will be used by the ship. Besides the main generator, that there is also an emergency generator is usually used when the main generator is not working or when the ship is on blackout condition.

1.2 Problem Formulations

Based on the description of the background on which was submitted, so there are several issues, among others:

1. How about the values of the power generator in SUCCESS VICTORY XXXIV?
2. How about the conditions of the generator in SUCCESS VICTORY XXXIV?
3. Is it has already suitable condition with regulation in the electrical system in the ship?
4. How to optimize the power of generator after re-constructing the calculation?

I.3 Limitation problem:

1. This analysis takes the data focus on the power of generator, current, voltage, and frequency.
2. This analysis data will be held on the MT SUCCESS VICTORY XXXIV.
3. This data will be taken based on four condition of ship: Sailing, Maneuvering, Loading and Discharging, and Anchoring.
4. This data will be taken every single condition when generator distributes the power.

I.4 Aims:

This thesis aims to:

1. Know the power capacity value in real condition on the ship.
2. Know the power capacity value in design of MT SUCCESS VICTORY XXXIV.
3. Evaluate the condition of the generator on the ship.
4. Compare the value of power generator on ship with first design, real condition, and Indonesian Shipyard (PT PAL) requirements.

I.5 Benefits:

Benefits to be gained from this final project are:

1. Giving the knowledge about the generator in the ship.
2. Giving the assessment about condition of generator.
3. Can be a reference to the owner for optimizing generator after being evaluated.

CHAPTER II
THEORITICAL FRAMEWORK

2.1 Ship Electrical System Arrangement

The main function in Ship Electrical System is to distributing all of the electrical items in ship with safe conditions. Swithcboad is the important element in distributing power because it contains the panels and main board to supplies power to motors group. Transformers, Fuse, Circuit Breakers placed in strategically Ship Electrical System to disconnect circuit if there was fault in the systems.

Based on regulation, the main switchboard placed in Engine Control Room to monitor the power distribution for electrical items on ship. The engineer must know the knowledge about power distribution on ship. To know about power distribution on ship, engineer have to study the ship's power diagrams. Almost all oceangoing ships have an A.C. distribution system in preference to a direct current D.C. system. This system usually adapted with shore practiceand also allows normal industrial equipment to be used after being adapted and certified where and if necessary, so it can withstand the conditions on board of a ship (e.g. vibration, freezing and tropical temperatures, humidity, the salty atmosphere, etc. encountered in various parts of the ship). (MAES, 2013)

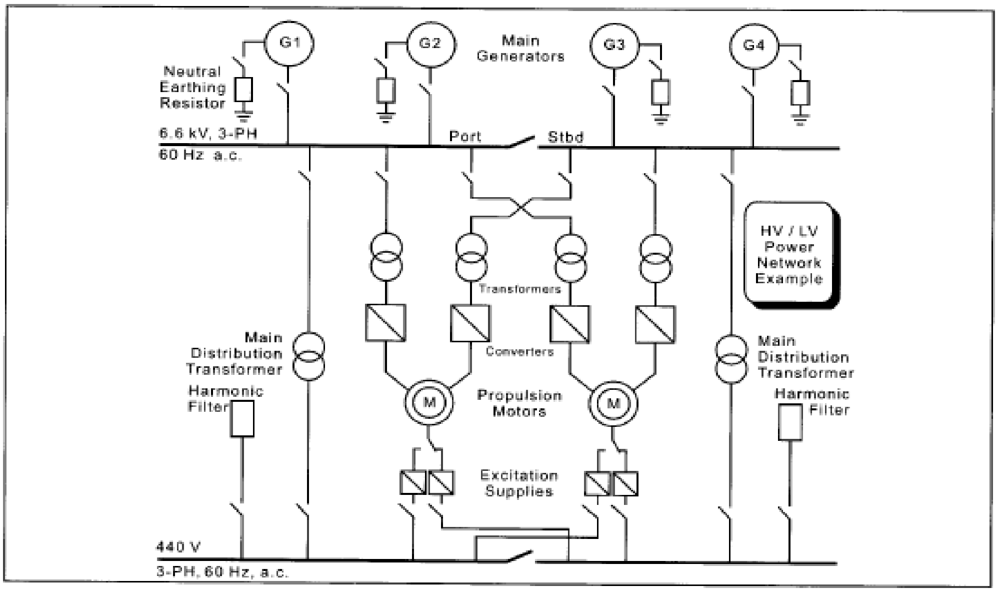

Figure 2. 1 Schematic Diagram of Ship Electrical System
(Source: Practical Marine Electrical Knowledge, 1999)

Synchronous generator always used in marine application to distributing high voltage in electrical system in ship. Synchronous machines are excited by direct current. In all but very small generators the rotor is the exiter of the generator. The direct current can be supplied to the rotor from an external exciting device via slip rings (brushed excitation) or via a small AC generator and rectifier on the rotor shaft (brush-less excitation). An automatic voltage regulator (AVR) controls de exciting current. The AVR keeps the generators voltage in the set value, regardless of changes in load, temperature and frequency. (MAES, 2013)

2.2 Generator

2.2.1 Synchronus AC Generator

A rotating field and with the armature windings on the stationary frame usually exist in Synchronous a.c. generators. Inverted constructions are also available and in this type the armature is rotating. But it has aimitations in the size and complexity of the sliprings and brushgear limit the inverted construction to about 150 kV A, so the generator must be paralleled with another generator to increase the power. (Watson, 1957)

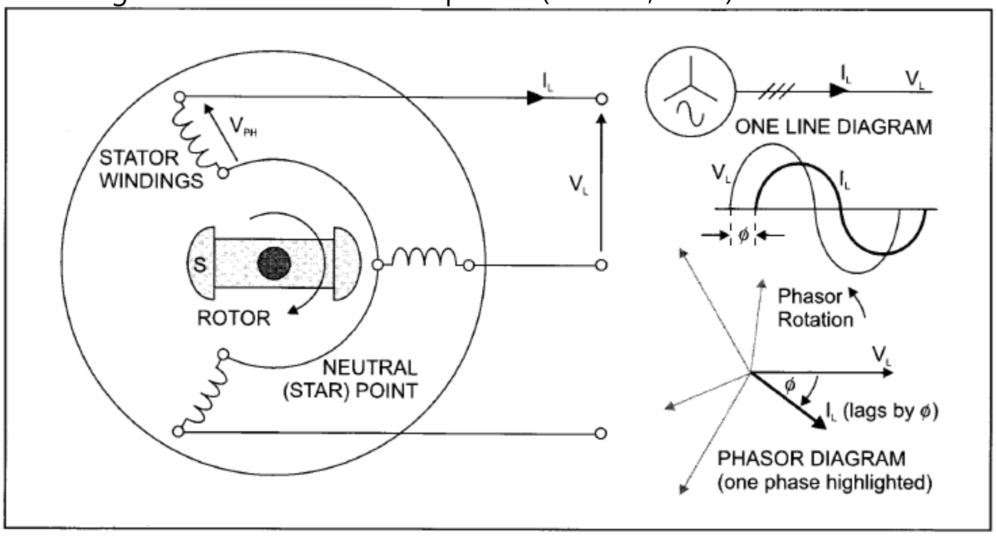

Figure 2. 2 Sycnchronus AC Generator Characteristic
(Source: Practical Marine Elecrical Knowledge, 1999)

The salient-pole type is familiar on generator usage for marine application, in which the field poles will be similar to those of a d.c. generator and projecting towards the air gap. Alternatively, generators of the non-salient or cylindrical construction with distributed field windings embedded in slots may be used. The cylindrical type is generally used in high-speed turbogenerators. (Watson, 1957)

2.2.2 Construction

The two main parts of any rotating a.c. machine are its stator and rotor. The fabricated steel stator frame supports the stator core and its three phase windings. The stator core is assembled from laminated steel with the windings housed in slots around the inner periphery of the cylindrical core.

The rotor of a main a.c. generator provides the field excitation from its electromagnetic poles. The shaft bearings of large generators (and motors) are usually insulated to prevent stray currents from circulating through.

To prevent the flow of shaft current, one bearing (usually the non-drive end) is electricallv isolated from earth bv a thin layer of insulating material beneath the bearing pedestal. The pedestal holding-down bolts must also be insulated by suitable sleeving The rotor poles are supplied with direct current (d.c.) from an exciter.

To eliminate the maintenance problems associated with rotating contacts, a brushless arrangement is usual for marine generators. All brush gear, commutators and slip rings are eliminated by using an a.c. exciter with its output being rectified by shaft-mounted silicon diodes.

Power losses, typically 10% of the generator rating, cause internal heating in the windings and magnetic cores of both rotor and stator. This heat must be continuously transferred out of the generator io prevent excessive temperature rise causing breakdown of winding insulation

Cooling air is forced through ventilation ducts in the stator core, between rotor poles and through the air gap (a few millimetres) between stator and rotor. Water cooling of the circulating air may also be used for generators with a large power rating. Temperature detectors (resistance type, thermistors or thermocouples) are used to monitor the temperature of stator windings, bearings and the cooling air/water of the generator. Single or grouped temperature alarms are activated at the main watchkeeping position. While the generator is stopped during standby or maintenance periods, low power electric heaters within the machine prevent internal condensation forming on the winding insulation.
(Hall, 1999)

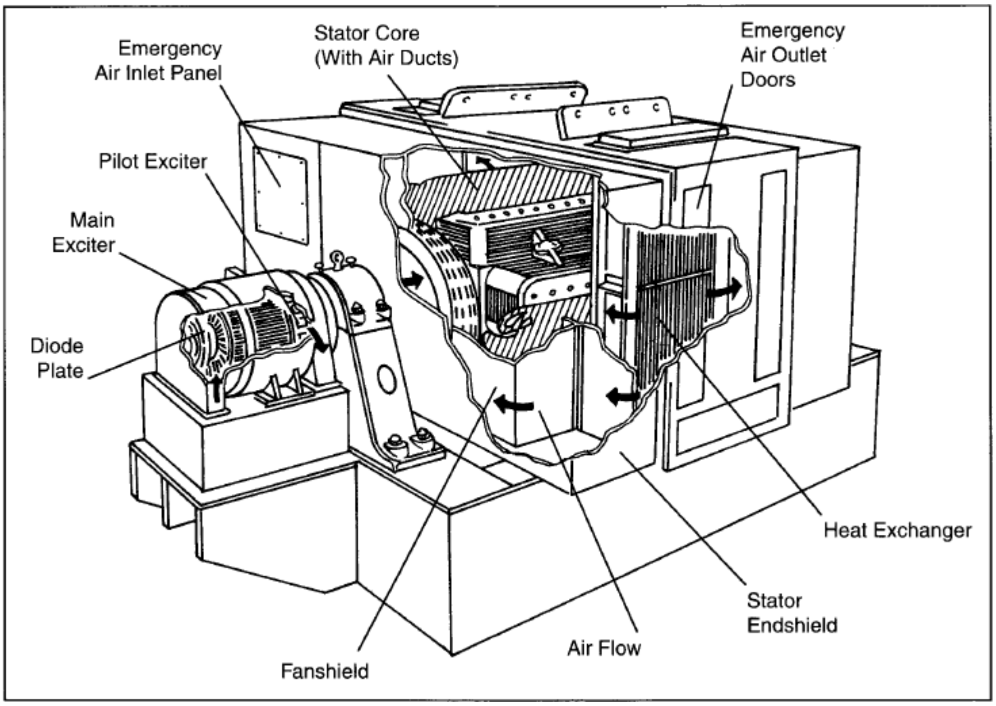

Figure 2. 3 Construction AC Generator
(Source: Practical Marine Electrical Knowledge, 1999)

2.3 Observating Generator

There are some things that must be considered in evaluating the generator on a ship:

2.3.1 Kind of Ship Condition

1. Sailing: when the ship was sailing many requirements that use on the ship because this condition is the ship's longest operation and this condition as a reference to calculate the capacity of the generator. (Sarwito, 1995)
2. Maneuvering: To know how much the power of generator that used when the ship making some movements, in this case, balancer and blower may possible to use. (Sarwito, 1995)
3. Loading and Discharging: This Condition may utilize the highest power of generator on ship like turning gear, cargo gear, pump, etc. (Sarwito, 1995)
4. Anchoring: To know how much the power of generator that used when the ship was anchoring. (Sarwito, 1995)

2.3.2 Diversity Factor

The electrical equipment on the ship has a specific character for its load. Several diversity of equipments are rarely used at the same time and continuously at a certain period. These inequalities need to be considered to calculate the capacity of the generator. Types of the load in the operation of electrical equipment on board consist of:

1. Continuous load: equipments to operate continuously at four conditions of the ship. Which belong to equipment are off the lights, air conditioning systems, pumps for CPP, and others.
2. Intermittent load: equipment in operation do not continuously operate at four conditions of the ship but periodically work with the period, for example fuel transfer pumps, fresh water pumps, and others.

2.3.3 Load Factor

Genset selection can be finished After the load factor was obtained. Load factor is Obtained from initial ship design data and The load factor is based Under the operational conditions and Operational equipment that is carried out at PT.PAL. Then from operational conditions. The equipment is divided into two conditions Namely continuous load and intermittent load. (Sitepu, 2010)

1. Load Factor generator: defined as the ratio between the power is using in one condition with amount of the generator usage (usually one or two depend with total of generators on ship).

$$LF = \frac{\text{Power is using for x Condition}}{\text{Total generator(in power) for x condition}}$$

2. Load factor equipment: defined as the ratio between the time to those on the equipment in a condition with the total time for a condition:

$$LF = \frac{\text{Usage Equipment's time for x Condition}}{\text{Total time for x condition}}$$

Table 2. 1 Load Factor Table

Table. **Definition of Continous Load and Load Factor f_o**

Kind of Auxiliary Machinery			Load Factor f_o: Normally at sea	Load Factor f_o: Arrival & Departure	Load Factor f_o: Cargo Handling	Remarks
Auxillary Machinery for diesel ships	Cooling freshwater pumps		85	85		
	Cooling sea water pumps		85	85		
	Lubricating oil pumps		65	65		
	Fuel valve cooling freshwater pumps		85	85		
	Fuel valve cooling oil pumps		70	70		
	Grade-C heavy oil purifiers and pumps		65			
	Fuel oil clarifiers and pumps		65			
	Booster pumps		65	65		
	Aux. Boiler use	Feed water pumps	85	85	85	
		Fuel oil burning pumps	65	65	85	
		Forced draft fans	85	85	85	
	Exhaust gas boiler circulating water pump		85			
	Air compressor			85		
	Generator cooling water pumps				85	
Aux. Machinery commonly used for diesel and turbine ships	Freshwater pumps		85	85	85	
	Sanitary pumps		85	85	85	
	Ventilating fans		85	85	85	
	Pumps fitted on distilling plant		85			
Deck Machinery	Winches				30 ~ 40	To be considered according to the number installed and
	Cargo oil pumps				30	
	Steering gear		20	20		
	Accomoda-tion space	Fans	80	80	50	
		Electric heaters	80	80	50	
		Air conditioning equipment	80	80	50	
	Electric fans		80	80	50	
	Pumps room ventilating fans				80	
	Cargo hold ventilating fans		60 ~ 80	60 ~ 80		Not include fans for cargo hold desiccator
	Hot water circulating fans		80	80	80	
	Refrigerator	For provision	60	80 *	60	* mark to be calculated by adding installation number
		For cargo	60	80 *	80 *	- d i t t o -
	Innert gas fans for cargo oil		70	70	85 *	
	LPG re-liquefying compressor		90	90	90	
	LPG cargo pump					
	Innert gas generator for LPG		80			
	Refrigerated container		45 ~ 65	45 ~ 65	45 ~ 65	
Others	Cargo lamps	Fixed		100	100	
		Portable			80	
	Projectors				80	
	Funnel Lights			100	100	
	Lighting	Accomodation	80	80	70	
		Engine room	100	100	100	Not include hand lamps.
		Navigation lights	100	100		
	Motor generator		70	70	70	
	Gyro-compass		80	80		
	Radar			100		
Auxillary Machinery for turbin ships	Main circulating pump		75 ~ 90	75 ~ 90		
	Generator circulating pumps		80 ~ 90	80 ~ 90	80 ~ 90	
	Main feed pumps	Cargo ship	65 ~ 70	50 ~ 60		
		Tanker	75 ~ 80	50 ~ 60		
	Auxiliary feed pumps					Continous load only during cargo handling. Load factor is to be determined according to actual operating conditions
	Main condensate pumps		65 ~ 75	50 ~ 60		
	Auxiliary condensate pumps					When the main condesate pumps are not used for generator condesate transfer. Load factor is to be determined according to actual operating conditions
	Lubricating oil pumps		60 ~ 70	60 ~ 70		
	Fuel oil burning pumps		70 ~ 80	75 ~ 85	75 ~ 85	

Auxillary Machinery for turbin ships (cont.'d)	Forced draft fans	When speed and vane control	A	Cargo ship	55 ~ 65	50 ~ 60		Lower values for sirocco type and high values for turbo-vane type fans. Load factor during cargo handling is to be determined according to actual operating conditions
				Tanker	65 ~ 75	50 ~ 60		
			B	Cargo ship	65 ~ 75	55 ~ 65		Usage of fans A. B :
				Tanker	68 ~ 75	55 ~ 65		No. of fan installed / No. of sets in
		When dumper control		Cargo ship	75 ~ 85	70 ~ 80		A / 2 sets/ 2 boilers / 2
				Tanker	80 ~ 90	70 ~ 80		B / 2 sets/ 2 boilers / 1 : up to 85% 2 : 85% and over
	Drain pumps	When LPSG" in-scalled		Cargo ship	70	70	70	B / 3 sets/ 2 boilers / 1 : up to 85% 2 : 85% and over
				Tanker	60 ~ 75	55 ~ 70	80 ~ 90	
		Without LPSG" in-scalled		Cargo ship	70	70	70	In case of motor driven deck machinery
					25	25	75	In case of steam driven deck machinery
				Tanker	55 ~ 70	55 ~ 70	75 ~ 90	
	Automatic combustion control devices				80 ~ 90	80 ~ 90	80 ~ 90	
	Soot blowing air compressor				80 ~ 90			To be calculated as intermittent load depending on the type of boiler.
	Ship's service air compressor				80 ~ 90	80 ~ 90	80 ~ 90	In case of automatic starting device is installed
	Turning motor					80 ~ 90	80 ~ 90	
Aux. Machinery for diesel ships	A grade heavy fuel oil purifier and pumps				* 65		* 65	For the case that ship mainly uses C grade heavy fuel oil during sea going. However when the ship uses A grade heavy fuel oil during sea going the purifiers are to be continous load
	Turning motor						* 80	
Aux. Machinery commonly used in diesel and turbine ships	General service pumps				* 65	* 65		
	Bilge pumps				85			
	Ballast pumps				85		85	
	Fuel oil transfer pumps				80		* 80	When sea water is used as ballast, ballast pump should be marked with *.
	Lubricating oil extraxtion pumps				80		80	
	Lubricating oil purifiers				* 80		80	There may be a case to be used as a continous load
Deck machinery	Windlasses					* 40		
	Boat winches						80	
	Butterworth pump				85			In case of tanker this pump should be * marked and the general service pump is to be * marked.
	Stripping pumps				15 ~ 25		55 ~ 65	
	Accommodation ladder winch					80		
	Capstans and mooring winches					* 40		
Others	Galley, pantry and laundry service			Electric range	* 40 ~ 60	* 40 ~ 60	* 40 ~ 60	Considerations are to be given according to type and particular of installation
				Electric oven	*40 ~ 60	* 40 ~ 60	* 40 ~ 60	- d i t t o -
				Others	40	40	40	Considerations are to be given when the equipment of large capacity is to be installed particularity
	Projectors					* 80		
	Motor generator for battery use				80	80	80	
	Radar				* 100			
	Radio equipment				* 80			
	Nautical instruments				* 60	* 60		
	Motor siren and motor horn				80	80		

Note : 1. Fire pump, machine tools, electric welder and hoists are not to be considered in the electric power consumption calculation.

2. * LPSG : Low Pressure Steam Generator

* mark show the load which becomes the largest consumable load among the auxiliary machinery used intermittently during sea going.

* mark show intermittent loads which are used simultancouslywith the auxiliary machinery marked with *.

(Source: Perencanaan Instalasi Listrik Kapal, 1995)

2.3.4 Ship Electric Power Analysis

The power factor can be defined As an angle whose forming the zero byway between the current and the voltage at the frequency certain. Active power is used for Operate the loads on the electricity customer. The power is generated by the generator that is transmitted to the electricity customer. (Antonov & Natalinus, 2013).

Electrical power in the Three phases AC power system consists of three components, the name are compelx power, active power, and reactive power. The meaning of complex power is the amount of voltage and Current are used for converted electrical energy per Unit time. Complex power contains components Real and imaginary of the given power. (Alimuddin, 2014)

A balanced three phase load is one that is equally shared (balanced) across all three phases. The total load is determined by adding up the individual kW balanced loads. In the balanced systems, the average power consumed by each load branch is the same and given by

$$\tilde{P}_{av} = V_{eff} I_{eff} \cos\phi$$

where V_{eff} is the effective value of the phase voltage, I_{eff} is the effective value of the phase current and ϕ is the angle of the impedance. The total average power consumed by the load is the sum of those consumed by each branch, hence, we have

$$P_{av} = 3\tilde{P}_{av} = 3V_{eff} I_{eff} \cos\phi$$

In the balanced Y systems, the phase current has the same amplitude as the line current $I_{eff} = (I_{eff})_L$, whereas the line voltage has the effective value $(V_{eff})_L$ which is $\sqrt{3}$ times greater than the effective value of the phase voltage, $(V_{eff})_L = \sqrt{3}V_{eff}$. Hence, using (22), we obtain

$$P_{av} = 3\frac{(V_{eff})_L}{\sqrt{3}}(I_{eff})_L \cos\phi = \sqrt{3}(V_{eff})_L (I_{eff})_L \cos\phi$$

Similarly, we derive:

The conversion formula is as follows:

$$\text{KW gen} = \text{kW load} = \text{kVA x PF} = \frac{\sqrt{3} \text{ x volts x current x PF}}{1000}$$

Note :

PF = power factor of load

Volts = rated line to line voltage
Current = rated line current

An unbalanced 3 phase load is one in which the load is not equally distributed over all the three phases. To obtain the equivalent 3 phase rating the highest single phase loading must be multiplied by 3. An unbalanced load give rise to unequal phase to phase and phase to neutral
voltages. In the unbalanced systems, there are adding the powers of each phase

$$P_{av} = (V_{eff})_a (I_{eff})_a \cos\phi_a + (V_{eff})_b (I_{eff})_b \cos\phi_b + (V_{eff})_c (I_{eff})_c \cos\phi_c$$

$$P_x = (V_{eff})_a (I_{eff})_a \sin\phi_a + (V_{eff})_b (I_{eff})_b \sin\phi_b + (V_{eff})_c (I_{eff})_c \sin\phi_c \ .$$

The formula is as follows:

$$\text{KW gen} = \frac{3 \text{ x volts (line to neutral) x current x PF}}{1000}$$

Note :
PF = power factor of load
Volts = rated line to line voltage
Current = rated line current

2.3.5 Tolerance Voltage and Frequency in Ship

All electrical appliances supplied from the main or emergency systems are to be so designed and manufactured that they are capable of operating satisfactorily under the normally occurring variations in voltage and frequency. Unless otherwise stated in the national or international standards, all equipment should operate satisfactorily with the variations from its rated value shown in the Tables 1 to 3 on the following conditions.

1. For alternative current components, voltage and frequency variations shown in the Table 1 are to be assumed.
2. For direct current components supplied by d.c. generators or converted by rectifiers, voltage variations shown in the Table 2 are to be assumed.
3. For direct current components supplied by electrical batteries, voltage variations shown in the Table 3 are to be assumed.

Any special system, e.g. electronic circuits, whose function cannot operate satisfactorily within the limits shown in the Table should not be supplied directly from the system but by alternative means, e.g. through stabilized supply.

Table 2. 2 Voltage and Frequency for AC Distribution Systems

Quantity in Operation	Variation	
	Permanen	Transient
Frequency	±5%	±10% (5 sec)
Voltage	+6%, -10%	±20% (1.5 sec)

(Source: IACS Requirement, 2016)

Table 2. 3 Voltage Variation for DC Distribution Systems

Parameters	Variations
Voltage tolerance (continuous)	±10%
Voltage cyclic variation deviation	5%
Voltage ripple (a.c. r.m.s. over steady d.c. voltage)	10%

(Source: IACS Requiremet, 2016)

Table 2. 4 Voltage Variations for Battery Systems

Systems	Variations
Components connected to the battery during charging (see Note)	+30%, -25%
Components not connected to the battery during charging	+20%, -25%
Note: Different voltage variations as determined by the charging/discharging characteristics, including ripple voltage from the charging device, may be considered.	

(Source: IACS Requirements, 2016)

CHAPTER III
RESEARCH METHOD

3.1 General

This chapter describes systematically stages which done in this research. This research method all activities, rules, and analysis that are implemented to solve problems defined on this final project.

3.2 Final Project Research Method

This final project is done by an experiment to analyze the performance of a generator in MT SUCCESS VICTORY XXXIV. The project is done in several stages. At below, the explanation of each stage are:

3.2.1 Identification and Formulation of the Problem

The final project begins by identifying and formulating the problem that will be done and also limits of the problems. This stage can make it easier for completion of this final project. The identification and formulation of the problem can be seen in the previous chapter.

3.2.2 Study Literature

The study of literature is an early stage is a stage of learning about the basic theories to be discussed or used in the final project. The basic theory of the Load factor in Ship that generated by the parallel generator. Literature was obtained from:

a. Journal
b. Paper
c. Script
d. Book
e. Internet

3.2.3 Collecting Data

Experiments were performed at the MT SUCCESS VICTORY XXXIV Chemical Tanker, which is owned by Soechi Chemical Tanker. Experiments were done by performing the testing process of the performance of the generator used, and load factor that showed in switchboard panel.

3.2.4 Calculating and Processing Data

a. Calculating of Load Factor Generator

The Calculation of generator efficiency taken from input power in complex power (VA) of this parallel generator in MT SUCCESS VICTORY XXXIV that showed in switchboard panel.

b. Calculating of Cos φ

The Calculation of Cos φ uses formula Cos $\varphi = \frac{\mathrm{P}}{V\ x\ I\ x\ \sqrt{3}}$

c. Calculating Continuous Load and Intermittent Load

The Calculation of Continuous Load and Intermittent Load earned by the required power table from Murakami Shipyard.

3.2.5 Evaluating Results

Evaluates the calculation that it is possible to fulfill the rules in calculation from design or not.

3.2.6 Analyzing Generator

Analyzes the difference value of power generator between in real condition (ship) and in design to get the factor that must be possible from this comparison.

3.2.7 Conclusions and Recommendations

The conclusion of this final project is to answer the condition in generator MT SUCCESS VICTORY XXXIV. There is comparison value between ship and ship electrical arrangement. The value used for comparison are load factor and efficiency of the generator. This final project can be used as a reference for maintaining the ship soon based on regulation.

3. 3 Bachelor Thesis and Colloquium Flowchat

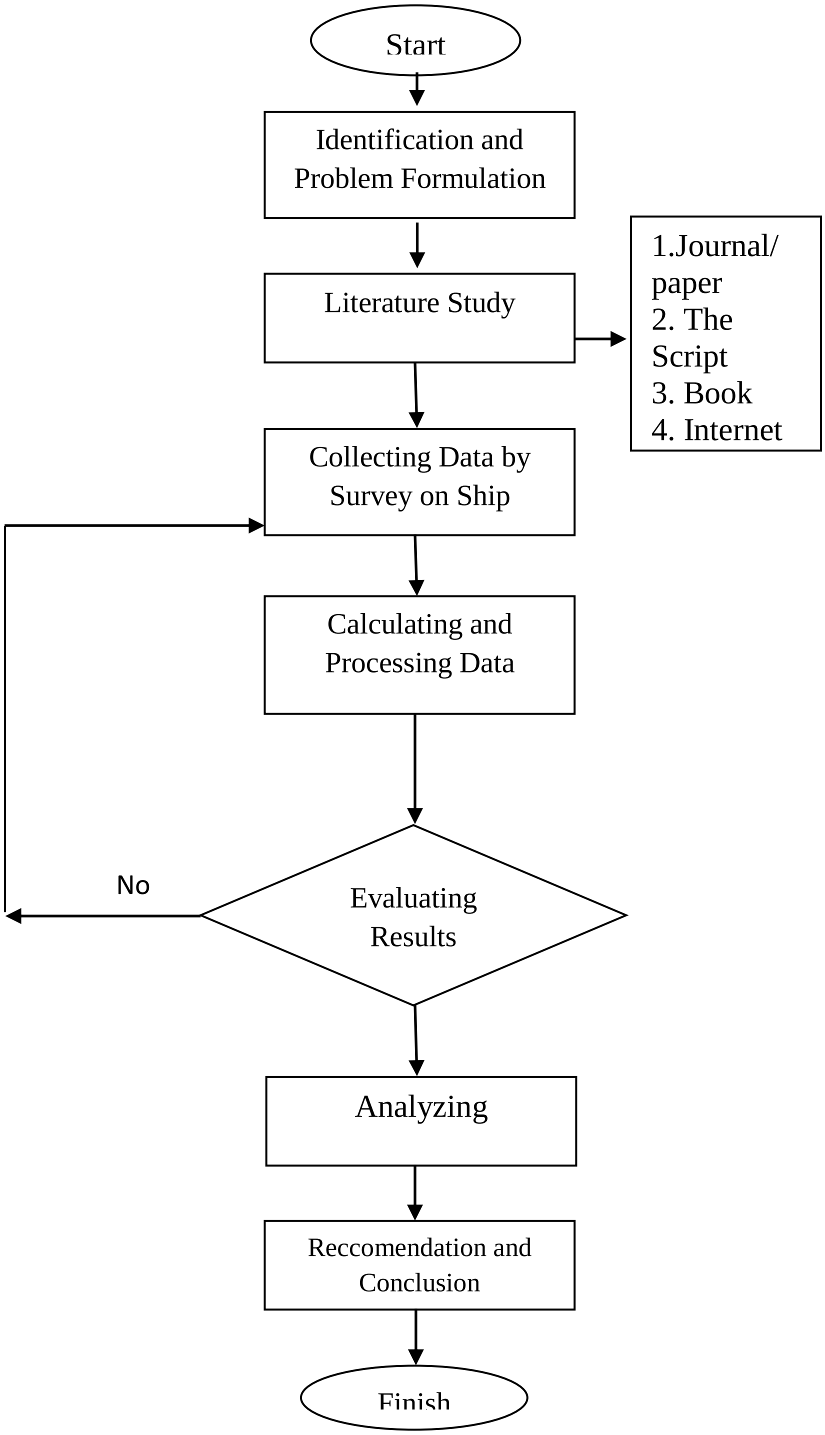

Figure 3. 1 Bachelor Thesis and Colloquium Flowchart

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CHAPTER IV
DATA ANALYSIS

4.1 Spesification Data

This thesis uses data from Chemical Tanker ship (MT SUCCESS VICTORY XXXIV) as an Object for this observation and takes P, V, I f from its switchboard panel to analyze and evaluate the condition of its generator. Built on November 1999, this ship has a couple of generators for operating its electrical equipment. Figure 4.1 until Figure 4.3 explain the data Principal Particulars of Ship, Wiring Diagram, as the first steps to choose its generator with power capcity about 400 kVA and Table 4.1 explains about calculation power table of MT SUCCESS VICTORY XXXIV.

4.1.1 Principal Particulars – MT SUCCESS VICTORY XXXIV

This Ship was built in Murakami Shipyard/Japan, launched on 1st November 1999 and delivered on 15th February. Now from figure 4.1, this ship has Indonesian flag and get a port of registry in Jakarta but it does not change its Classification Society, and still use NK as a Classification society of Ship.Principal Particulars attached:

Figure 4. 1 MT SUCCESS VICTORY XXXIV

LOA : 105 m

LPP : 97 m

Breadth : 16.8 m

Depth : 8.4 m

Height : 34 m

Delivered : 15th February 2000

Shipyard : Murakami Ship Building

Main Engine : Akasaka Diesel 6UEC 37 LA

Generator : TAIYO (Yanmar S156L-UTx 2 set)

4.1.2 Generator Set – MT SUCCESS VICTORY XXXIV

The electrical system on MT SUCCESS VICTORY is supplied by 2 generators with its capacity 400 kVA for one generator. Before getting the suitable power for this generator, Murakami Shipyard made wiring diagram to MT SUCCESS VICTORY XXXIV to explain power distribution of MT SUCCES VICTORY XXXIV. Figure 4.2 represents about the distribution of wiring diagram on MT SUCCESS VICTORY XXXIV.

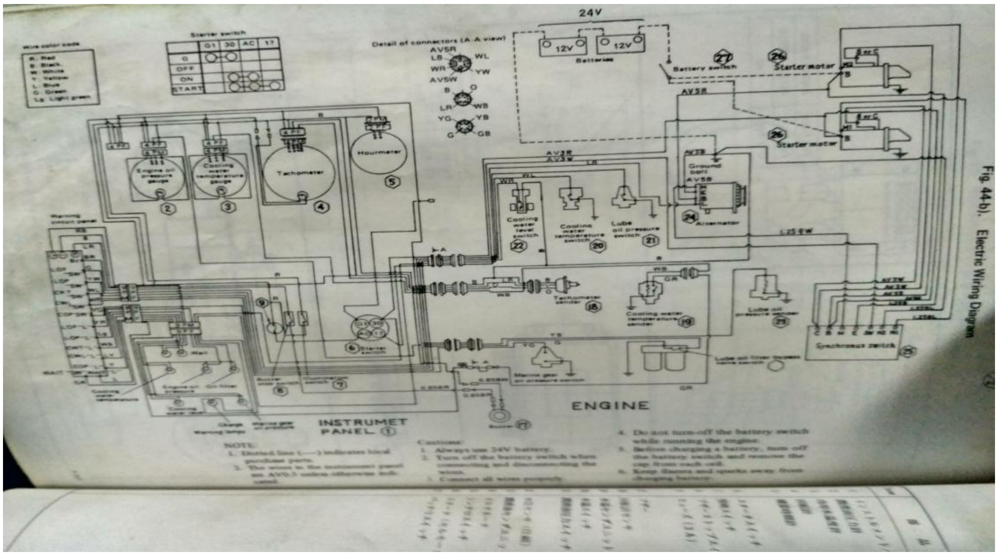

Figure 4. 2 Wiring Diagram of MT SUCCESS VICTORY XXXIV

After getting the wiring diagram, this shipyard calculated electric power table for each condition to reach the most efficient power in Table 4.1. According to these calculation items based on design, the generators have maximum capacity of power 344.1 kVA in sailing condition, 552.3 kVA in

Maneuvering condition, 712.8 kVA when the ship is in loading and discharging/discharging condition, and 149.1 kVA in Anchoring condition.

Table 4. 1 Calculation Power Table from Murakami Shipyard

Inspected Items		Electric Motor		Total Input Power (Kw)	Consumption rate（%） and Electric Power Comsumption Amount（Kw）								Remark
		Amount of Unit	Output Power (Kw)		During Sailing		During Entry-Departure Port Process		During Loading and Unloading		During Anchorage		
					%	(Kw)	%	(Kw)	%	(Kw)	%	(Kw)	
	Steering Machine	1	5.5	6.3	40	2.5	50	3.2					
	Power Pack Electric Motor	3	145	152.6			70 x 2	213.6	80 x 3	412			
	Engine room exhaust fan	1	2.2	2.7	80	2.2	80	2.2	80	2.2	80	2.2	Piority cut-off
c	Butterworth pump	1	55	57.3	80	45.8							Piority cut-off
o	Gas-free Fan	1	37	39.3	80	31.4							Piority cut-off
n	Residencial Quarter Air Conditioning Unit; Compressor	1	5.5	6.3	80	5	80	5	80	5	80	5	
t	Observation room	1	0.2	0.3	80	0.2	80	0.2	80	0.2	80	0.2	
i	Engine room ventilator	2	7.5	8.3	80 x 2	13.2	80 x 2	13.2	80 x 2	13.2	80 x 2	13.2	
n	Pump room exhaust fan	1	2.2	2.7					80	2.2			
u	Main sea-water cooling pump	1	11	12.3	80	9.8	80	9.8					
o	Main fresh water cooling pump	2	5.5	6.3	80	5.1	80	5.1					
u	Main F.O. supply pump	2	1.5	1.9	80	1.4	80	1.4					
s	Spare L.O. pump	1	18.5	20.4			65	13.3					
	Sea-water service pump	1	15	17.3	80	13.8	80	13.8	80	13.8	80	13.8	
u	Sea-water cooler generator	1	5.5	6.3	80	5.1	80	5.1	80	5.1	80	5.1	
s	Auxiliary blower	2	15	16.3			80 x 2	26.1					
e	Fire extinguisher - misc. pump	1	37	40.3			75	30.2					
	Exhaust gas circulatory pump	2	2.2	2.7	80	2.2							
i	Water supply machine: Sea-water cooler pump	1	5.5	6.3	80	5.1							
t	Water supply machine: Vacuum pump	1	5.5	6.3	80	5.1							
e	Water supply machine: Distilled water pump	1	0.75	0.9	80	0.7							
m	F.O. Purrifier	2	5.5	6.3	80 x 2	10.1	80	5	80	5	80	5	
s	L.O. Purrifier	1	5.5	6.3	80	5							
	Transformer（AC100 load）	3		15	40 x 3	18	50 x 3	22.5	50 x 3	22.5	35 x 3	15.8	
	Warm water circulatory pump	1	0.4	0.5	80	0.4	80	0.4	80	0.4	80	0.4	
	Power Pack Hydraulic oil pump	1	2.6	3.1			80	2.5	80	2.5			

Inspected Items		Electric Motor		Total Input Power (Kw)	Consumption rate（%）and Electric Power Comsumption Amount（Kw）								Remark
		Amount of Unit	Output Power (Kw)		During Sailing		During In-Out Port Proccess		During Loading and Unloading		During Anchorage		
					%	(Kw)	%	(Kw)	%	(Kw)	%	(Kw)	
	ODM Sumpling pump	1	2.2	2.7	80	2.2							
	Lifesaving boat: davit	1	3.7	4.3									
	Lifesaving boat（passenger use）	1	18.5	20.3									
I	Foam fire extinguishing pump	1	11	12.3									
n	Waste oil tank stove	1		3									
t	Cooking room fan	1	0.2	0.3	80	0.2	80	0.2	80	0.2	80	0.2	Also function as vaporizer at the same time
e	Residence quarter Air Conditioning Unit; Compressor	1	15	17.3	80	13.8	80	13.8	80	13.8	80	13.8	
r	Observation room	1	2.2	2.7	80	1.4	80	1.4	80	1.4	80	1.4	Priority cut-off
m	Provision davit	1	1.5	1.8									
i	Provisions freezer	2	3	3.3	80	2.6	80	2.6	80	2.6	80	2.6	
t	Cooking range	1		19	70	13.3	70	13.3	70	13.3	70	13.3	
t	Supporting Boiler: Fan	1	37	40.3	80	32.2	80	32.2	80	32.2	80	32.2	
e	Supporting Boiler: F.O. Pump	1	2.2	2.7	80	2.2	80	2.2	80	2.2	80	2.2	
n	Supporting Boiler: F.O. Heater			17									
t	Supporting Boiler: Water supply pump	2	11	12.3	80	9.8	80	9.8	80	9.8	80	9.8	
	Supporting Boiler: waste oil pump	1	0.4	0.5									
u	Calorifier	1		3									
s	Main Air Compressor	2	18.5	20.4	80	16.3	80	16.3	80	16.3			
e	Fresh water pump	1	37	42.3	70	29.6							
	Ballast pump	1	30	32.3					70	22.6			
i	AFO transfer pump	1	1.5	1.8	80	1.4	80	1.4	80	1.4	80	1.4	
t	CFO transfer pump (Engine room)	1	2.2	2.7	80	2.2							
e	L.O. transfer pump	1	0.75	0.9	80	0.7							
m	Engine room bilge pump	1	0.75	0.9									
s	Sludge pump	1	1.5	1.8									
	Purifier pump	2	2.2	2.7	80 x 2	4.3	80 x 2	4.3	80 x 2	4.3	80 x 2	4.3	
	Electric chain lock	1	1.3	1.6									
	Electric welding machine	1		28									

Inspected Items		Electric Motor: Amount of Unit	Electric Motor: Output Power (Kw)	Total Input Power (Kw)	Consumption rate（%） and Electric Power Comsumption Amount（Kw）: During Sailing %	During Sailing (Kw)	During In-Out Port Proccess %	During In-Out Port Proccess (Kw)	During Loading and Unloading %	During Loading and Unloading (Kw)	During Anchorage %	During Anchorage (Kw)	Remark
continuous use items	CFO Transfer pump（bow）	1	3.7	4.3	80	3.4	80	3.4	80	3.4	80	3.4	Also function as vaporizer at the same time
	Pump room bilge pump	1	3.7	4.3					80	3.4			
	Disposer	1	1.5	1.8	80	1.4	80	1.4	80	1.4	80	1.4	
	Turning motor main engine	1	1.5	1.8									
	Stuffing box L.O. Pump	1	0.4	0.5	80	0.4							
	Ladder winch	2	1.5	1.8									
	Piston horn	1	5.5	6.3									
	Sewage processing unit / treatment	1	0.4	5	80	0.4							
	Soup kettle	1		6	70	4.2	70	4.2	70	4.2	70	4.2	
	Waste oil incinerator	1	1.5	1.8	80	1.4							
Required Electric Power	Intermittent used Items	Total (Kw)			143.4		106.5		132.5				
		Invalid rate (%)			65		65		65		65		
		Required electric power (Kw)			93.2		69.2		86.1		5		
	continuous used items	Required electric power (Kw)			182		372.6		484.1				
	Intermittent used items＋continuous used items			(Kw/KVA)	275.3/344.1		441.8/552.3		570.2/712.8		119.3/149.1		
Generator Output Power（KVA) x amount（unit)					400 x 1		400 x 2		400 x 2		400 x 1		
Generator Loading Rate （%）					86		69		89.1		37.3		
Electrical equipment specification					AC 445 V x 3 Phase x 60 Hz x 6 P x 400 kVA								

After getting a wiring diagram and calculation power table in Murakami Shipyard, MT SUCCESS VICTORY XXXIV required the power of generator with capacity 400 kVA for one generator and it needs two generators for operating its electrical equipment. Figure 4.3 shows Specification of Generator and re-writes above its original specification to clear the nameplate.

Model	: TAIYO - TWY35C.65
Output	: 400 kVA
Frequency	: 60Hz
Volt	: 445 Vlot
Ampere	: 519 A
Number of Phase	: 3
Power Factor	: 0.8
Number of Poles	: 6
Amb Temperature	: 45 C
Insulation	: F Class

Figure 4. 3 Specs of Generator

4.2 Observation Data of MT SUCCESS VICTORY XXXIV

From problem limitation of this thesis. This route taken for four ports in Indonesia, they were Gresik to Discharge Methanol and Probolinggo also to Discharge Methanol. And for loading Methanol MT SUCCESS VICTORY XXXIV sailed to Bontang, and back for Discharging in Merak. This observation noted P,V, I, and f (attached in Chapter of Attachment on the last page) that showed in panel every single hour in 4 conditions (Sailing, Maneuvering, Loading/Discharging, Anchoring) of ship to calculate Load Factor and Cos φ of generators.

These graphics from Figure 4.4 until Figure 4.17 represent the Data Observation from Load Factors and Cos φ in 4 routes every single hours from the calculation and Formulas of Load Factors and Cos φ are:

$$LF = \frac{\text{Power is using for x Condition}}{\text{Total generator(in power) for x condition}}$$

$$\text{Cos } \varphi = \frac{\text{P}}{V\ x\ I\ x\ \sqrt{3}}$$

4.2.1 Gresik

In The port of Gresik, this ship discharged 4000 Tons of Methanol for one day. After discharging, this ship maneuvered out to the port and did anchoring near the port to bunker, because there is also another ship want to load or discharge in the port of Gresik. After bunkering, MT SUCCESS VICTORY XXXIV continued its trip to Probolinggo to discharge its load again. Figure 4.4 until Figure 4.6 show condition activities of MT SUCCESS VICTORY in The port of Gresik.

1. Based on analysis of Cos Φ and load factor of generators when the ship discharged its load, cos φ of generators was still good but load factor of generators was lower than the calculation in Murakami Ship yard and when the ship was in cargo handling condition, it needed 89.1% load factor capacity of generators, but in actual condition the highest load factor of generators was 36%. Figure 4.4 shows Graphic of Load Factor and Cos φ in Discharging condition on Gresik.

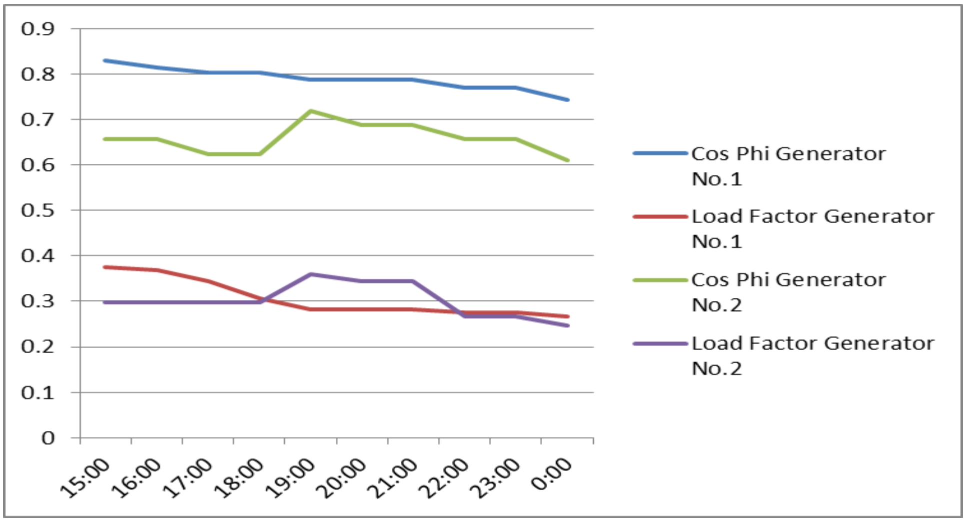

Figure 4. 4 Graphic of Cos φ and Load Factor Generator No.1 and 2 in Discharging Condition

2. According to this analysis of Cos Φ and load factor of generators from Figure 4.5 when the ship was in anchoring condition, cos φ of generator was still good and load factor of generator almost same with the calculation in Murakami Ship yard and when the ship was in anchoring condition it needed 37.3% load factor capacity of generator, but in actual condition the highest load factor of generator was 34%.

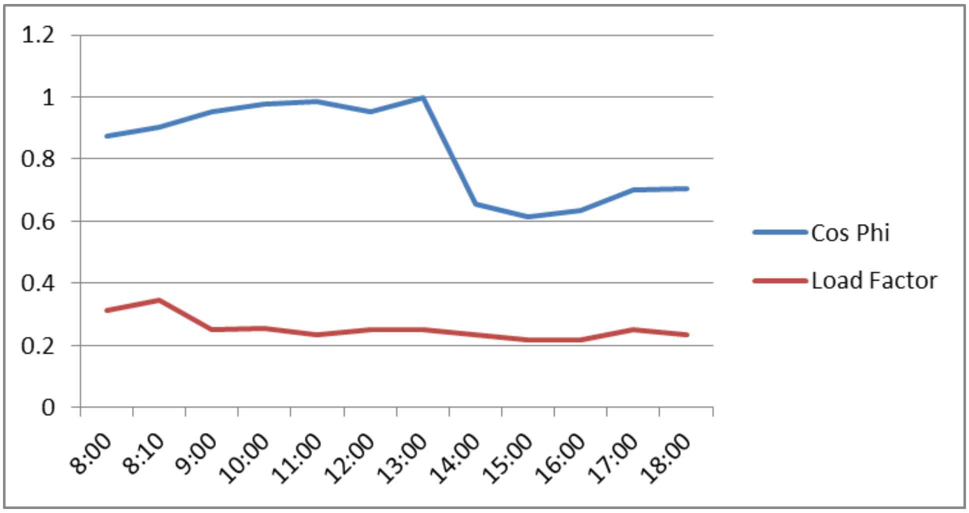

Figure 4. 5 Graphic of Cos φ and Load Factor Generator No.1 in Anchoring Condition

3. Regarding from the analysis of Cos Φ and load factor of generators shows in Figure 4.6 when the ship was in maneuvering condition, cos φ of generators was still good but load factor of generators was lower than the calculation in Murakami Ship yard and when the ship was in maneuvering condition it needed 86% load factor capacity of generators, but in actual condition the highest load factor of generators was 43%.

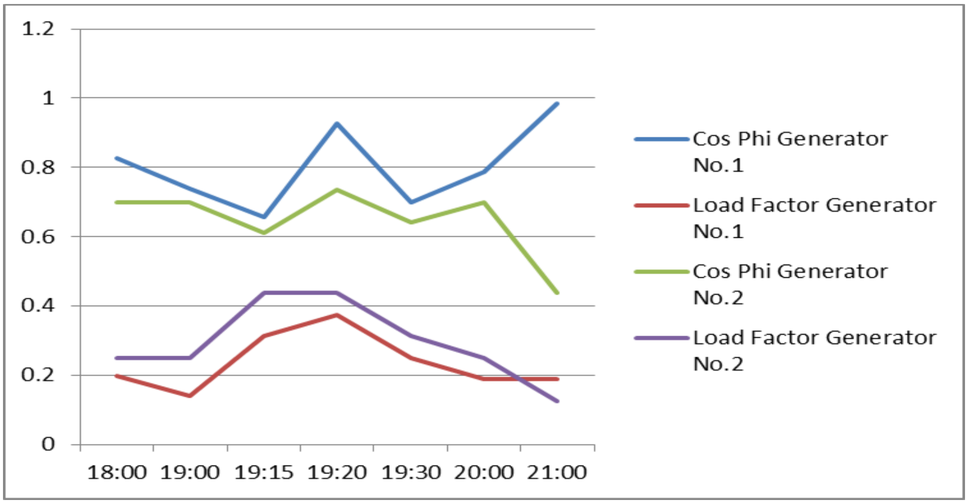

Figure 4. 6 Graphic of Cos φ and Load Factor Generator No.1 and 2 in Maneuvering Condition

4.2.2 Probolinggo

In this port, this ship sailed almost two days and waited for discharging for two days because there were also two ships discharging in the same port. After getting its turn to discharge, this ship discharged 2000 Tons of Methanol for one day and left this port after discharging immediately. Figure 4.7 until Figure 4.11 show condition activities of MT SUCCESS VICTORY in The port of Probolinggo.

1. According to the analysis of Cos Φ and load factor of generator when the ship was in sailing condition, cos φ of generator was still good but load factor of generator was lower than the calculation in Murakami Ship yard and when the ship was in sailing condition it needed 69% load factor capacity of generator, but in actual condition the highest load

factor of generator was 35%. Figure 4.7 shows its graphic of Cos φ and Load Factor in sailing condition.

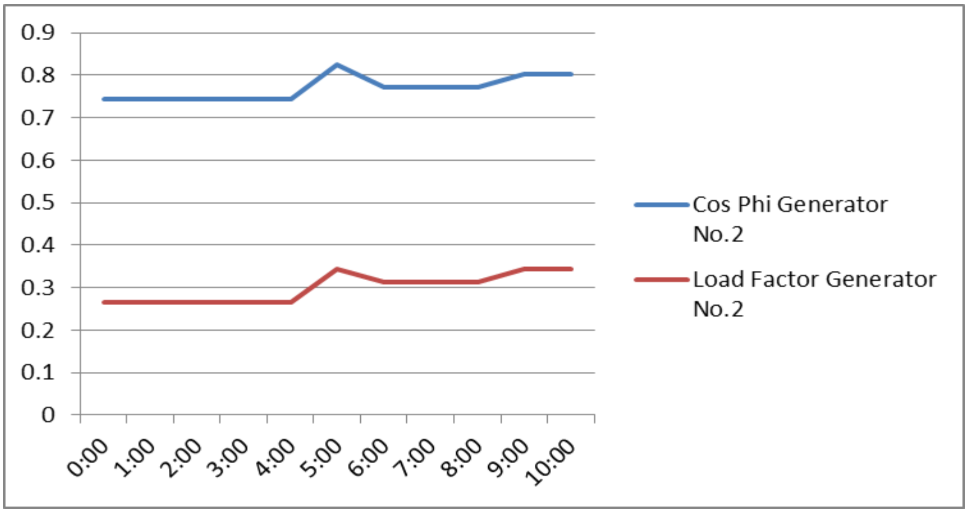

Figure 4. 7 Graphic of Cos φ and Load Factor Generator No.2 in Sailing condition

2. From Figure 4.8 the data analysis of Cos Φ and load factor of generator when the ship was in anchoring condition, cos φ of generator was still good and load factor of generator almost same with the calculation in Murakami Ship yard and when the ship was in anchoring condition it needed 37.3% load factor capacity of generator, but in actual condition the highest load factor of generator was 31%.

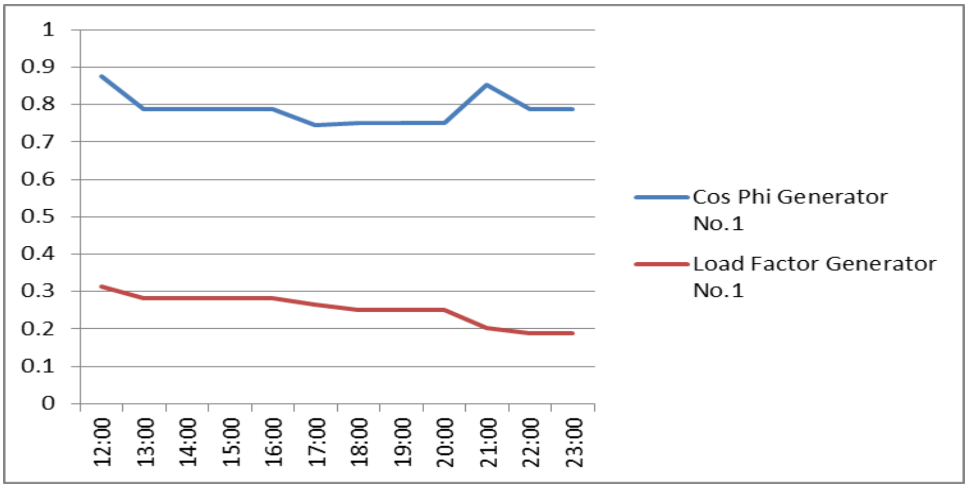

Figure 4. 8 Graphic of Cos φ and Load Factor Generator No.1 in anchoring condition

3. Based on Figure 4.9, the analysis of Cos Φ and load factor of generators when the ship was in anchoring condition, cos φ of generator was still good and load factor of generator almost same with the calculation in Murakami Ship yard and when the ship was in anchoring condition it needed 37.3% load factor capacity of generator, but in actual condition the highest load factor of generator was 31%.

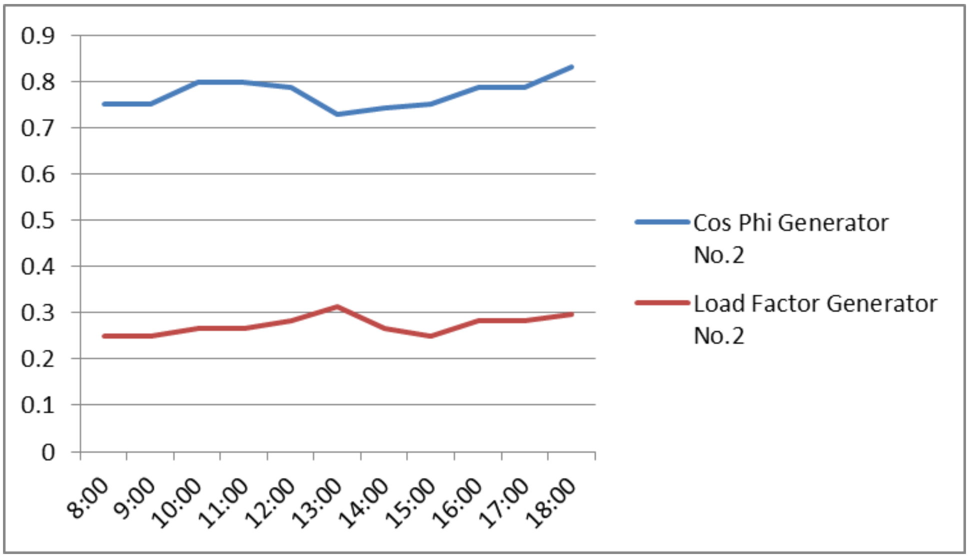

Figure 4. 9 Graphic of Cos φ and Load Factor Generator No.2 in Anchoring condition

4. Regarding from the analysis of Cos Φ and load factor of generators when the ship discharged its load, cos φ of generators was still good but load factor of generators was lower than the calculation in Murakami Ship yard and when the ship was in cargo handling condition it needed 89.1% load factor capacity of generators, but in actual condition the highest load factor of generators was 36%, Figure 4.10 represents Cos φ and Load Factor in Discharging condition in The port of Probolinggo.

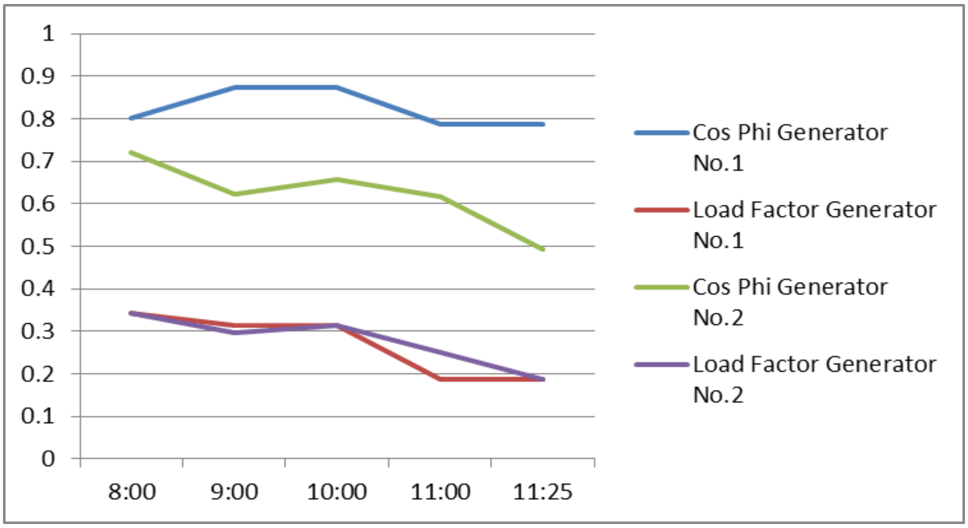

Figure 4. 10 Graphic of Cos φ and Load Factor Generator Generator No.1 and 2 in Discharging Condition

5. According to the analysis of Cos Φ and load factor of generators in Figure 4.11 when the ship was in maneuvering condition, cos φ of generators was still good but load factor of generators was lower than the calculation in Murakami Ship yard and when the ship was in maneuvering condition it needed 86% load factor capacity of generators, but in actual condition the highest load factor of generators was 43%.

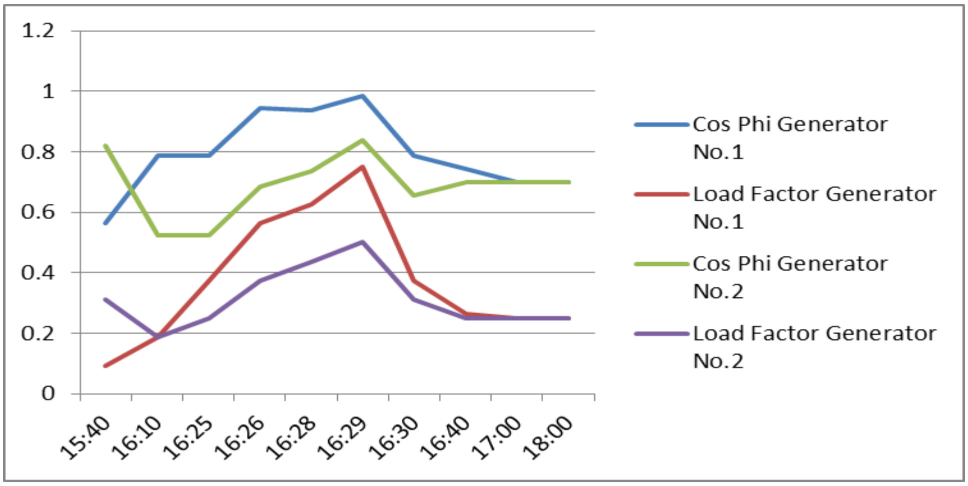

Figure 4. 11 Graphic of Cos φ and Load Factor Generator No.1 and 2 in Maneuvering Condition

4.2.3 Bontang

In Bontang, this ship came back to charge its load with full capacity. But in this case, this ship waited 4 days to charge the load because the port in this city is very busy. After charging its load with Methanol again, this ship sailed to Banten for discharging its load in 2 ports in Banten (Merak and Anyer). Figure 4.12 until Figure 4.15 show condition activities of MT SUCCESS VICTORY in The port of Bontang.

1. From Figure 4.12 the analysis of Cos Φ and load factor of generator when the ship was in sailing condition, cos φ of generator was still good but load factor of the generator was higher at the moment than the calculation in Murakami Ship yard (at the moment 81%). When the ship was in sailing condition it needed 69% load factor capacity of the generator, but in actual condition the highest load factor of the generator was 48%.

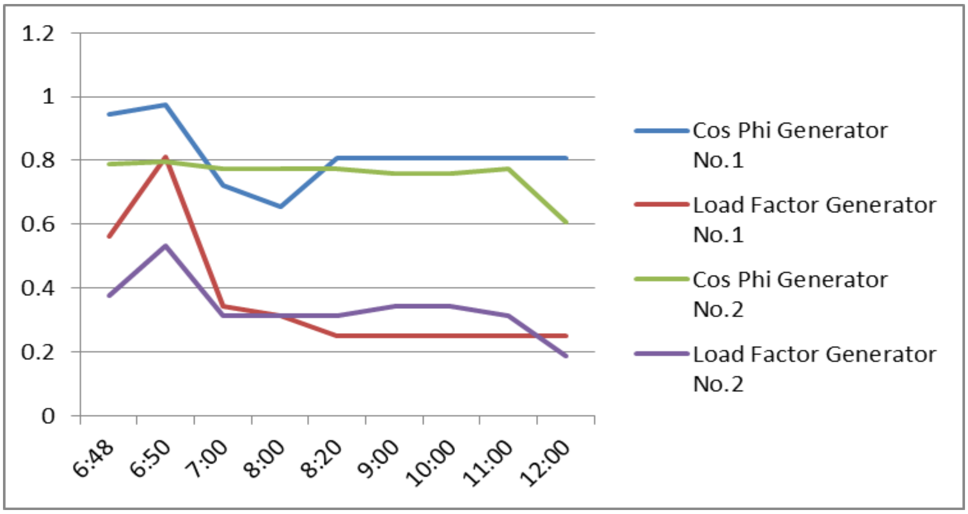

Figure 4. 12 Graphic of Cos φ and Load Factor Generator No.1 and 2 in Sailing Condition

2. Regarding from Figure 4.13, the analysis of Cos Φ and load factor of generator when the ship was in anchoring condition, cos φ of generator was still good and load factor of generator almost same with the calculation in Murakami Ship yard nd when the ship was in anchoring condition it needed 37.3% load factor capacity of generator, but in actual condition the highest load factor of generator was 31%.

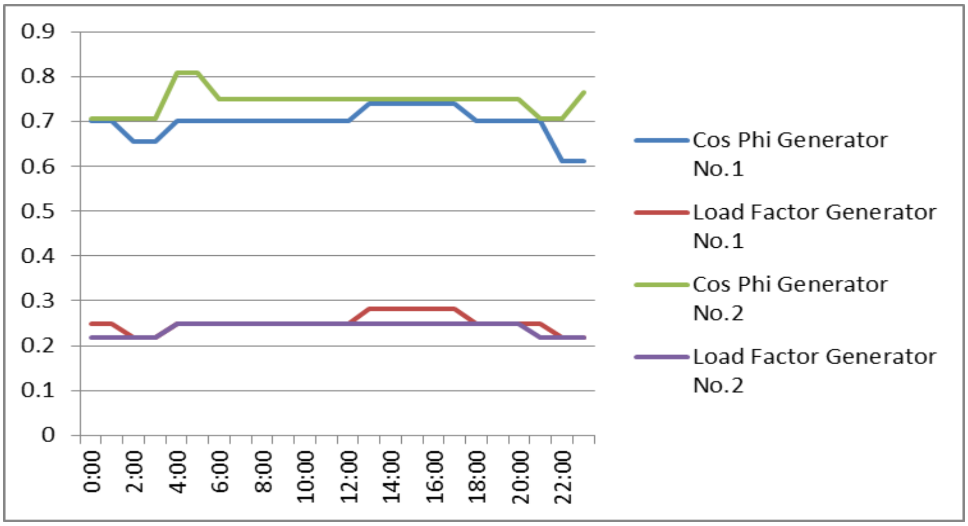

Figure 4. 13 Graphic of Cos φ and Load Factor Generator No.1 and 2 in Anchoring condition (switched when 24 hours running)

3. According to the analysis of Cos Φ and load factor of generator when the ship was in loading condition, cos φ of generator was still good and load factor of generator almost same with the calculation in Murakami Ship yard and when the ship was in loading condition it needed 89.1% load factor capacity of generator, but in actual condition the highest load factor of generator was 34%. Figure 4.14 shows the graphic Cos φ and Load Factor in loading condition.

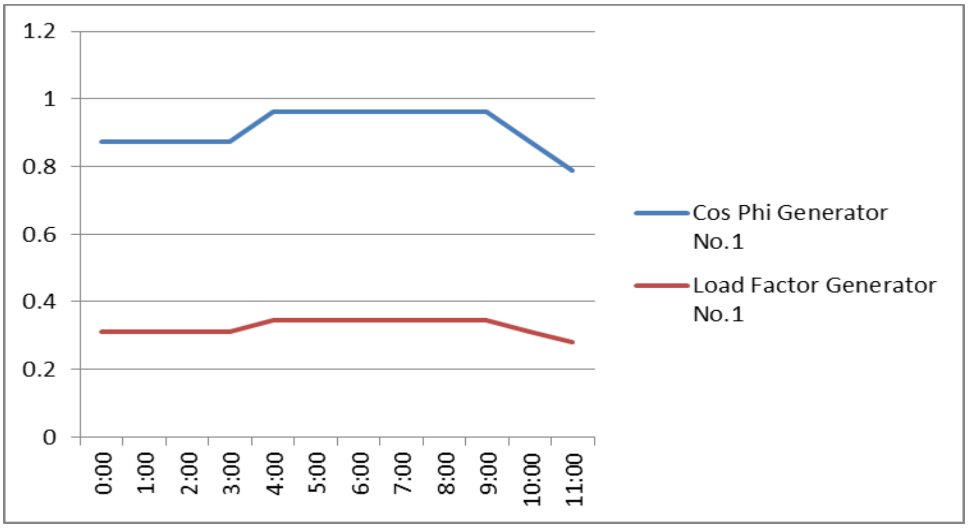

Figure 4. 14 Graphic of Cos φ and Load Factor Generator No.1 in Loading Condition

4. Based on analysis of Cos Φ and load factor of generators in Figure 4.15 when the ship was in maneuvering condition, cos φ of generators was still good but load factor of generators was lower than the calculation in Murakami Ship yard and when the ship was in maneuvering condition it needed 86% load factor capacity of generators, but in actual condition the highest load factor of generators was 50%.

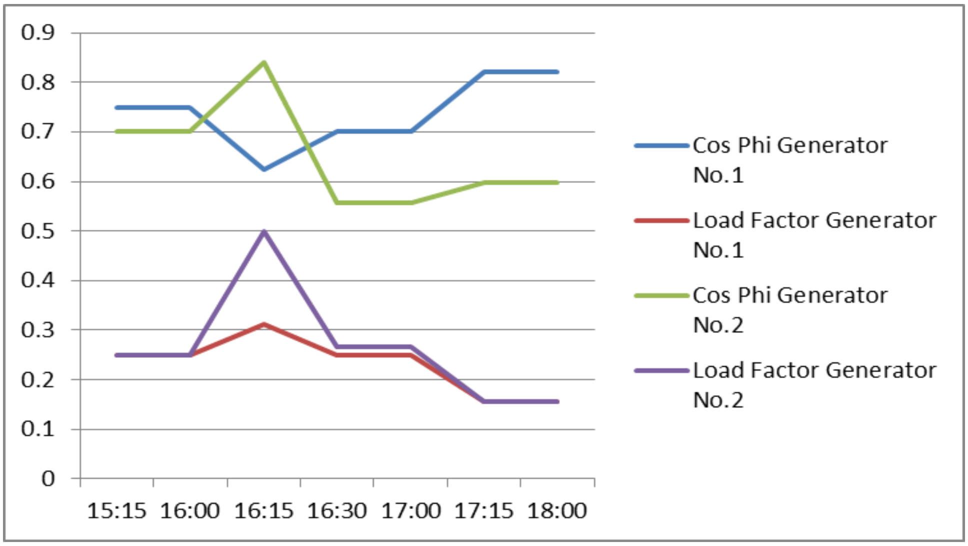

Figure 4. 15 Graphic of Cos φ and Load Factor Generator No.1 and 2 in Maneuvering Condition

4.2.4 Merak

Merak was the last destination of this observations. This thesis did not note all of the activity in Merak, because its data has completed. So, in Merak just only noted about this ship in sailing and maneuvering condition. Figure 4.16 and Figure 4.17 show graphics of Cos φ and Load Factor in The port of Merak.

1. According to the analysis of Cos Φ and load factor of the generator in Figure 4.16 when the ship was in sailing condition, cos φ of the generator was still good but load factor of the generator was lower than the calculation in Murakami Ship yard. When the ship was in sailing condition it needed 69% load factor capacity of the generator, but in actual condition the highest load factor of generator was 33%.

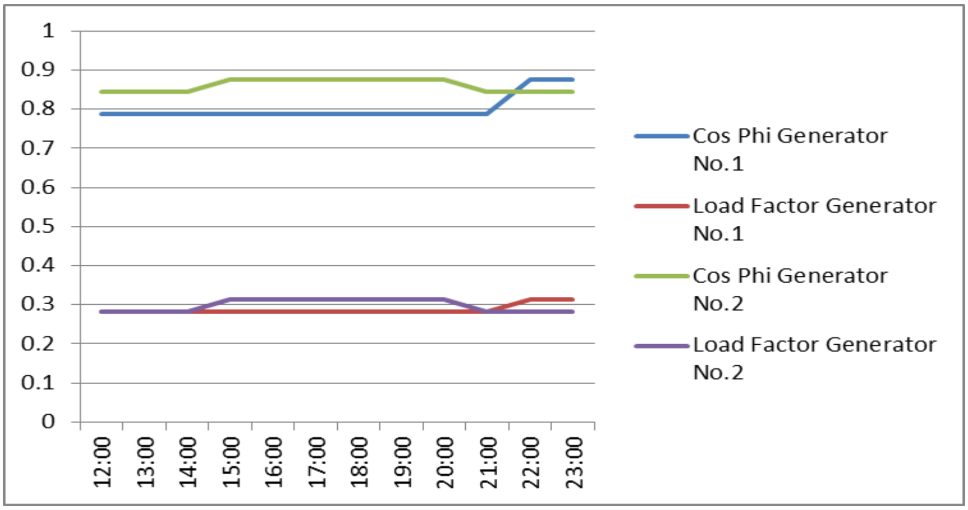

Figure 4. 16 Graphic of Cos φ and Load Factor Generator No.1 and 2 in Sailing condition (Switched Every 12 hours)

2. From Figure 4.17, the analysis of Cos Φ and load factor of generators when the ship was in maneuvering condition, cos φ of generators was still good but load factor of generators was lower than the calculation in Murakami Ship yard and when the ship was in maneuvering condition it needed 86% load factor capacity of generators, but in actual condition the highest load factor of generators was 50%.

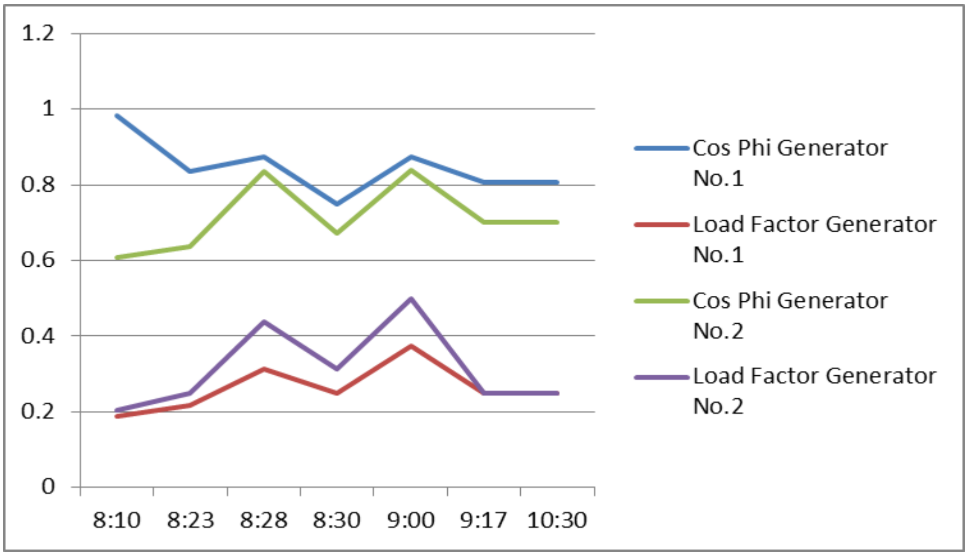

Figure 4. 17 Graphic of Cos φ and Load Factor Generator No.1 and 2 in Maneuvering Condition

4.2.5 Summaries of Cos φ and Load Factor of Generators

Cos φ in every conditions of generator in good condition because from graphics show the percentage of Cos φ is in a range from 70% until 80%, but for Load Factor in every condition is very low if they compare with the first design because from the graphics show the percentage of Load Factor is only 30% and the highest is 67%.

The generator should be in good condition based on Cos φ and Load Factor, so to know more details about the condition of the generator, the author calculates electric power table and after getting all of the summaries, the generator can be analyzed and evaluated.

4. 3 Calculation Table of Electric Power Table Comparison

After getting the table of activities and Graphics of activities based on Load Factor and Power Factor (cos Φ), this thesis needs all of the items that used in MT SUCCESS VICTORY XXXIV to calculate the capacity for generators in real condition because there was the different capacity of power between design and real condition.

Beside calculation by design and real condition, this thesis also calculates by Indonesian Shipyard (PT PAL) Requirements calculation table of electric power table. So with these comparisons, this thesis will get the best conclusion and give comments and advice to the owner of MT SUCCESS VICTORY XXXIV about his generators.

For the last steps, this thesis also makes a calculation again based on the highest and the lowest power in every condition in switchboard’s panel on this ship to ensure and analyze the calculation that may closer with that three comparisons before (calculation table of electric power table based on: Design, Indonesian Shipyard (PT PAL) Requirements, and in real condition).

4.3.1 Calculation Table of Electric Power Table Based on Design in Murakami Shipyard

This table calculates items based on the design using load factor from Murakami shipyard to know power capacity of generator MT SUCCESS VICTORY XXXIV.

Table 4. 2 Required Electric Power Table Based on Design in Murakami Shipyard

	Inspected Items	Electric Motor		Total Input Power (Kw)	Consumption rate (%) and Electric Power Comsumption Amount (Kw)								Remark
		Amount of Unit	Output Power (Kw)		During Sailing		During Entry-Departure Port Process		During Loading and Unloading		During Anchorage		
					%	(Kw)	%	(Kw)	%	(Kw)	%	(Kw)	
continuous use items	Steering Machine	1	5.5	6.3	40	2.5	50	3.2					
	Power Pack Electric Motor	3	145	152.6			70 x 2	213.6	80 x 3	412			
	Engine room exhaust fan	1	2.2	2.7	80	2.2	80	2.2	80	2.2	80	2.2	Piority cut-off
	Butterworth pump	1	55	57.3	80	45.8							Piority cut-off
	Gas-free Fan	1	37	39.3	80	31.4							Piority cut-off
	Residencial Quarter Air Conditioning Unit; Compressor	1	5.5	6.3	80	5	80	5	80	5	80	5	
	Observation room	1	0.2	0.3	80	0.2	80	0.2	80	0.2	80	0.2	
	Engine room ventilator	2	7.5	8.3	80 x 2	13.2	80 x 2	13.2	80 x 2	13.2	80 x 2	13.2	
	Pump room exhaust fan	1	2.2	2.7					80	2.2			
	Main sea-water cooling pump	1	11	12.3	80	9.8	80	9.8					
	Main fresh water cooling pump	2	5.5	6.3	80	5.1	80	5.1					
	Main F.O. supply pump	2	1.5	1.9	80	1.4	80	1.4					
	Spare L.O. pump	1	18.5	20.4			65	13.3					
	Sea-water service pump	1	15	17.3	80	13.8	80	13.8	80	13.8	80	13.8	
	Sea-water cooler generator	1	5.5	6.3	80	5.1	80	5.1	80	5.1	80	5.1	
	Auxiliary blower	2	15	16.3			80 x 2	26.1					
	Fire extinguisher - misc. pump	1	37	40.3			75	30.2					
	Exhaust gas circulatory pump	2	2.2	2.7	80	2.2							
	Water supply machine: Sea-water cooler pump	1	5.5	6.3	80	5.1							
	Water supply machine: Vacuum pump	1	5.5	6.3	80	5.1							
	Water supply machine: Distilled water pump	1	0.75	0.9	80	0.7							
	F.O. Purrifier	2	5.5	6.3	80 x 2	10.1	80	5	80	5	80	5	
	L.O. Purrifier	1	5.5	6.3	80	5							
	Transformer (AC100 load)	3		15	40 x 3	18	50 x 3	22.5	50 x 3	22.5	35 x 3	15.8	
	Warm water circulatory pump	1	0.4	0.5	80	0.4	80	0.4	80	0.4	80	0.4	
	Power Pack Hydraulic oil pump	1	2.6	3.1			80	2.5	80	2.5			

Inspected Items		Electric Motor		Total Input Power (Kw)	Consumption rate（%） and Electric Power Comsumption Amount（Kw）								Remark
		Amount of Unit	Output Power (Kw)		During Sailing		During In-Out Port Proccess		During Loading and Unloading		During Anchorage		
					%	(Kw)	%	(Kw)	%	(Kw)	%	(Kw)	
Intermittent use items	ODM Sumpling pump	1	2.2	2.7	80	2.2							
	Lifesaving boat: davit	1	3.7	4.3									
	Lifesaving boat（passenger use）	1	18.5	20.3									
	Foam fire extinguishing pump	1	11	12.3									
	Waste oil tank stove	1		3									
	Cooking room fan	1	0.2	0.3	80	0.2	80	0.2	80	0.2	80	0.2	Also function as vaporizer at the same time
	Residence quarter Air Conditioning Unit; Compressor	1	15	17.3	80	13.8	80	13.8	80	13.8	80	13.8	
	Observation room	1	2.2	2.7	80	1.4	80	1.4	80	1.4	80	1.4	Priority cut-off
	Provision davit	1	1.5	1.8									
	Provisions freezer	2	3	3.3	80	2.6	80	2.6	80	2.6	80	2.6	
	Cooking range	1		19	70	13.3	70	13.3	70	13.3	70	13.3	
	Supporting Boiler: Fan	1	37	40.3	80	32.2	80	32.2	80	32.2	80	32.2	
	Supporting Boiler: F.O. Pump	1	2.2	2.7	80	2.2	80	2.2	80	2.2	80	2.2	
	Supporting Boiler: F.O. Heater			17									
	Supporting Boiler: Water supply pump	2	11	12.3	80	9.8	80	9.8	80	9.8	80	9.8	
	Supporting Boiler: waste oil pump	1	0.4	0.5									
	Calorifier	1		3									
	Main Air Compressor	2	18.5	20.4	80	16.3	80	16.3	80	16.3			
	Fresh water pump	1	37	42.3	70	29.6							
	Ballast pump	1	30	32.3					70	22.6			
	AFO transfer pump	1	1.5	1.8	80	1.4	80	1.4	80	1.4	80	1.4	
	CFO transfer pump (Engine room)	1	2.2	2.7	80	2.2							
	L.O. transfer pump	1	0.75	0.9	80	0.7							
	Engine room bilge pump	1	0.75	0.9									
	Sludge pump	1	1.5	1.8									
	Purifier pump	2	2.2	2.7	80 x 2	4.3	80 x 2	4.3	80 x 2	4.3	80 x 2	4.3	
	Electric chain lock	1	1.3	1.6									
	Electric welding machine	1		28									

Inspected Items		Electric Motor: Amount of Unit	Electric Motor: Output Power (Kw)	Total Input Power (Kw)	Consumption rate（%） and Electric Power Comsumption Amount（Kw）: During Sailing %	During Sailing (Kw)	During In-Out Port Proccess %	During In-Out Port Proccess (Kw)	During Loading and Unloading %	During Loading and Unloading (Kw)	During Anchorage %	During Anchorage (Kw)	Remark
continuous use items	CFO Transfer pump（bow）	1	3.7	4.3	80	3.4	80	3.4	80	3.4	80	3.4	Also function as vaporizer at the same time
	Pump room bilge pump	1	3.7	4.3					80	3.4			
	Disposer	1	1.5	1.8	80	1.4	80	1.4	80	1.4	80	1.4	
	Turning motor main engine	1	1.5	1.8									
	Stuffing box L.O. Pump	1	0.4	0.5	80	0.4							
	Ladder winch	2	1.5	1.8									
	Piston horn	1	5.5	6.3									
	Sewage processing unit / treatment	1	0.4	5	80	0.4							
	Soup kettle	1		6	70	4.2	70	4.2	70	4.2	70	4.2	
	Waste oil incinerator	1	1.5	1.8	80	1.4							
Required Electric Power	Intermittent used Items	Total (Kw)			143.4		106.5		132.5				
		Invalid rate (%)			65		65		65		65		
		Required electric power (Kw)			93.2		69.2		86.1		5		
	continuous used items	Required electric power (Kw)			182		372.6		484.1				
	Intermittent used items＋continuous used items (Kw/KVA)				275.3/344.1		441.8/552.3		570.2/712.8		119.3/149.1		
Generator Output Power（KVA) x amount（unit)					400 x 1		400 x 2		400 x 2		400 x 1		
Generator Loading Rate （%）					86		69		89.1		37.3		
Electrical equipment specification					AC 445 V x 3 Phase x 60 Hz x 6 P x 400 kVA								

According to these calculation items based on design, the generators have the maximum capacity of power 344.1 kVA in sailing condition, 552.3 kVA in Maneuvering condition, 712.8 kVA when the ship is in loading and discharging/discharging condition, and 149.1 kVA in Anchoring condition.

In this case, the maximum capacity of power is 712.8 kVA when the ship is in loading and discharging condition. Literally, shipyard can give a recommendation to the owner to install two generators with the total capacity for 720-750 kVA to reduce the cost of new generators. But based on rules, generator can handle the maximum power for only 90% and after that, the rest of the power moved to another generator. And in loading and discharging condition there is 89.1% generator usage.

So Murakami Shipyard gives a solution for the owner to install two generators with the capacity of power are 400 kVA and total the capacities are 800 kVA. Because in the final calculation of power table, the maximum capacity of power is when the ship in loading and discharging condition with the capacity reach until 712.8 kVA. that the generators use 3 power pack electric motors to turn on the hydraulic oil pump and other items that need high power to discharge the load.

4.3.2 Calculation Table of Electric Power Table based on Indonesian Shipyard (PT PAL) Requirements

This table calculates required electric power table based on the usage of item from Indonesian Shipyard (PT PAL) Requirements and also uses load factor from Indonesian Shipyard (PT PAL) Requirements too. The blue marks on this table represent the items belong to Indonesian Shipyard (PT PAL) Requirements table. From table 4.3 uses items and Load Factors from actual condition.

Table 4. 3 Required electric power Table based on Indonesian Shipyard (PT PAL) Requirements

SNO.		Shipowner							Ship type				
	Inspected Items	Electric Motor		Total Input Power (Kw)	Consumption rate（%）and Electric Power Comsumption Amount（Kw）								Remark
		Amount of Unit	Output Power (Kw)		During Sailing		During Entry-Departure Port Process		During Loading and Unloading		During Anchorage		
					%	(Kw)	%	(Kw)	%	(Kw)	%	(Kw)	
	Steering Machine	1	5.5	6.3	20	1.3	20	1.3					
	Power Pack Electric Motor	3	145	152.6			70 x 2	213.6	80 x 3	367			
	Engine room exhaust fan	1	2.2	2.7	80	2.2	80	2.2	80	2.2			Piority cut-off
c	Butterworth pump	1	55	57.3	85	48.7							Piority cut-off
o	Gas-free Fan	1	37	39.3	80	31.4							Piority cut-off
n	Residencial Quarter Air Conditioning Unit; Compressor	1	5.5	6.3	80	5	80	5	80	5			
t	Observation room	1	0.2	0.3	80	0.2	80	0.2	80	0.2			
i	Engine room ventilator	2	7.5	8.3	85 x 2	14	85 x 2	14	85 x 2	14			
n	Pump room exhaust fan	1	2.2	2.7					80	2.2			
u	Main sea-water cooling pump	1	11	12.3	85	10.5	85	10.5					
o	Main fresh water cooling pump	2	5.5	6.3	85	5.3	85	5.3					
u	Main F.O. supply pump	2	1.5	1.9	80	1.4	80	1.4					
s	Spare L.O. pump	1	18.5	20.4	65	13.3	65	13.3					
	Sea-water service pump	1	15	17.3	80	13.8	80	13.8	80	13.8			
u	Sea-water cooler generator	1	5.5	6.3					80	5.1			
s	Auxiliary blower	2	15	16.3			80 x 2	26.1					
e	Fire extinguisher - misc. pump	1	37	40.3			75	30.2					
	Exhaust gas circulatory pump	2	2.2	2.7	80	2.2							
i	Water supply machine: Sea-water cooler pump	1	5.5	6.3	80	5.1							
t	Water supply machine: Vacuum pump	1	5.5	6.3	80	5.1							
e	Water supply machine: Distilled water pump	1	0.75	0.9	85	0.75							
m	F.O. Purrifier	2	5.5	6.3	80 x 2	10.1	80	5	80	5			
s	L.O. Purrifier	1	5.5	6.3	80	5							
	Transformer（AC100 load）	3		15	40 x 3	18	50 x 3	22.5	50 x 3	22.5			
	Warm water circulatory pump	1	0.4	0.5	80	0.4	80	0.4	80	0.4			
	Power Pack Hydraulic oil pump	1	2.6	3.1			80	2.5	80	2.5			

Inspected Items		Electric Motor		Total Input Power (Kw)	Consumption rate（%）and Electric Power Comsumption Amount（Kw）								Remark
		Amount of Unit	Output Power (Kw)		During Sailing		During In-Out Port Proccess		During Loading and Unloading		During Anchorage		
					%	(Kw)	%	(Kw)	%	(Kw)	%	(Kw)	
Intermittent use items	ODM Sumpling pump	1	2.2	2.7	80	2.2							
	Lifesaving boat: davit	1	3.7	4.3									
	Lifesaving boat（passenger use）	1	18.5	20.3									
	Foam fire extinguishing pump	1	11	12.3									
	Waste oil tank stove	1		3									
	Cooking room fan	1	0.2	0.3	60	0.2	60	0.2	60	0.2			Also function as vaporizer at the same time
	Residence quarter Air Conditioning Unit; Compressor	1	15	17.3	80	13.8	80	13.8	80	13.8			
	Observation room	1	2.2	2.7	80	1.4	80	1.4	80	1.4			Priority cut-off
	Provision davit	1	1.5	1.8									
	Provisions freezer	2	3	3.3	80	2.6	80	2.6	80	2.6			
	Cooking range	1		19	60	11.4	60	11.4	60	11.4			
	Supporting Boiler: Fan	1	37	40.3	85	34	85	34	85	34			
	Supporting Boiler: F.O. Pump	1	2.2	2.7	65	1.7	65	1.7	85	2.2			
	Supporting Boiler: F.O. Heater			17									
	Supporting Boiler: Water supply pump	2	11	12.3	85	10.5	85	10.5	85	10.5			
	Supporting Boiler: waste oil pump	1	0.4	0.5									
	Calorifier	1		3									
	Main Air Compressor	2	18.5	20.4			80	16.3					
	Fresh water pump	1	37	42.3	85	36	85	36	85	36			
	Ballast pump	1	30	32.3					85	27.5			
	AFO transfer pump	1	1.5	1.8	85	1.5			85	1.5			
	CFO transfer pump (Engine room)	1	2.2	2.7	85	2.3							
	L.O. transfer pump	1	0.75	0.9	80	0.7							
	Engine room bilge pump	1	0.75	0.9	85	0.75							
	Sludge pump	1	1.5	1.8									
	Purifier pump	2	2.2	2.7	80 x 2	4.3	80 x 2	4.3	80 x 2	4.3			
	Electric chain lock	1	1.3	1.6									
	Electric welding machine	1		28									

	Inspected Items	Electric Motor: Amount of Unit	Electric Motor: Output Power (Kw)	Total Input Power (Kw)	Consumption rate（%） and Electric Power Comsumption Amount（Kw）: During Sailing %	During Sailing (Kw)	During In-Out Port Proccess %	During In-Out Port Proccess (Kw)	During Loading and Unloading %	During Loading and Unloading (Kw)	During Anchorage %	During Anchorage (Kw)	Remark
continuous items use	CFO Transfer pump（bow）	1	3.7	4.3	80	3.4	80	3.4	80	3.4			Also function as vaporizer at the same time
	Pump room bilge pump	1	3.7	4.3					80	3.4			
	Disposer	1	1.5	1.8	80	1.4	80	1.4	80	1.4			
	Turning motor main engine	1	1.5	1.8									
	Stuffing box L.O. Pump	1	0.4	0.5	80	0.4							
	Ladder winch	2	1.5	1.8			80	1.4					
	Piston horn	1	5.5	6.3	80	5.3	80	5.3					
	Sewage processing unit / treatment	1	0.4	5	80	0.4							
	Soup kettle	1		6	70	4.2	70	4.2	70	4.2			
	Waste oil incinerator	1	1.5	1.8	80	1.4							
Required Electric Power	Intermittent used Items	Total (Kw)			123.4		128		145.4				
		Invalid rate (%)			65		65		65				
		Required electric power (Kw)			80.2		83.1		94.5				
	continuous used items	Required electric power (Kw)			210		383		452.3				
	Intermittent used items＋continuous used items (Kw/KVA)				290.2/362.75		466.1/582.7		546.8/683.5				
Generator Output Power（KVA) x amount（unit)					400 x 1		400 x 2		400 x 2				
Generator Loading Rate （%）					90		72.8		85.4				
Electrical equipment specification					AC 445 V x 3 Phase x 60 Hz x 6 P x 400 kVA								

Table 4. 4 Required Electric Power Table based on Indonesian Shipyard (PT PAL) Requiremets with Actual Condition's Load Factor

SNO.		Shipowner							Ship type				
	Inspected Items	Electric Motor		Total Input Power (Kw)	Consumption rate（%） and Electric Power Comsumption Amount（Kw）								Remark
		Amount of Unit	Output Power (Kw)		During Sailing		During Entry-Departure Port Process		During Loading and Unloading		During Anchorage		
					%	(Kw)	%	(Kw)	%	(Kw)	%	(Kw)	
	Steering Machine	1	5.5	6.3	20	1.3	20	1.3					
	Power Pack Electric Motor	3	145	152.6			40 x 2	116	40 x 2	116			
	Engine room exhaust fan	1	2.2	2.7	80	2.2	80	2.2	80	2.2	80	2.2	Piority cut-off
c	Butterworth pump	1	55	57.3	85	48.7							Piority cut-off
o	Gas-free Fan	1	37	39.3	80	31.4							Piority cut-off
n	Residencial Quarter Air Conditioning Unit; Compressor	1	5.5	6.3	80	5	80	5	80	5	80	5	
t	Observation room	1	0.2	0.3	80	0.2	80	0.2	80	0.2	80	0.2	
i	Engine room ventilator	2	7.5	8.3	85 x 2	14	85 x 2	14	85 x 2	14	80	6.6	
n	Pump room exhaust fan	1	2.2	2.7					80	2.2			
u	Main sea-water cooling pump	1	11	12.3	85	10.5	85	10.5					
o	Main fresh water cooling pump	2	5.5	6.3	85	5.3	85	5.3					
u	Main F.O. supply pump	2	1.5	1.9	80	1.4	80	1.4					
s	Spare L.O. pump	1	18.5	20.4	65	13.3	65	13.3					
	Sea-water service pump	1	15	17.3	80	13.8	80	13.8	80	13.8	80	13.8	
u	Sea-water cooler generator	1	5.5	6.3					80	5.1	80	5.1	
s	Auxiliary blower	2	15	16.3			80 x 2	26.1					
e	Fire extinguisher - misc. pump	1	37	40.3			75	30.2					
	Exhaust gas circulatory pump	2	2.2	2.7	80	2.2							
i	Water supply machine: Sea-water cooler pump	1	5.5	6.3	80	5.1							
t	Water supply machine: Vacuum pump	1	5.5	6.3	80	5.1							
e	Water supply machine: Distilled water pump	1	0.75	0.9	85	0.75							
m	F.O. Purrifier	2	5.5	6.3	80 x 2	10.1	80	5	80	5	80	5	
s	L.O. Purrifier	1	5.5	6.3	80	5							
	Transformer（AC100 load）	3		15	40 x 3	18	50 x 3	22.5	50 x 3	22.5	35 x 3	15.8	
	Warm water circulatory pump	1	0.4	0.5	80	0.4	80	0.4	80	0.4	80	0.4	
	Power Pack Hydraulic oil pump	1	2.6	3.1			80	2.5	80	2.5			

Inspected Items		Electric Motor		Total Input Power (Kw)	Consumption rate（%） and Electric Power Comsumption Amount（Kw）								Remark
		Amount of Unit	Output Power (Kw)		During Sailing		During In-Out Port Proccess		During Loading and Unloading		During Anchorage		
					%	(Kw)	%	(Kw)	%	(Kw)	%	(Kw)	
Intermittent use items	ODM Sumpling pump	1	2.2	2.7	80	2.2							
	Lifesaving boat: davit	1	3.7	4.3									
	Lifesaving boat（passenger use）	1	18.5	20.3									
	Foam fire extinguishing pump	1	11	12.3									
	Waste oil tank stove	1		3									
	Cooking room fan	1	0.2	0.3	60	0.2	60	0.2	60	0.2	80	0.2	Also function as vaporizer at the same time
	Residence quarter Air Conditioning Unit; Compressor	1	15	17.3	80	13.8	80	13.8	80	13.8	80	13.8	
	Observation room	1	2.2	2.7	80	1.4	80	1.4	80	1.4	80	1.4	Priority cut-off
	Provision davit	1	1.5	1.8									
	Provisions freezer	2	3	3.3	80	2.6	80	2.6	80	2.6	80	2.6	
	Cooking range	1		19	60	11.4	60	11.4	60	11.4	70	13.3	
	Supporting Boiler: Fan	1	37	40.3	85	34	85	34	85	34	80	32.2	
	Supporting Boiler: F.O. Pump	1	2.2	2.7	65	1.7	65	1.7	85	2.2	80	2.2	
	Supporting Boiler: F.O. Heater			17									
	Supporting Boiler: Water supply pump	2	11	12.3	85	10.5	85	10.5	85	10.5	80	9.8	
	Supporting Boiler: waste oil pump	1	0.4	0.5									
	Calorifier	1		3									
	Main Air Compressor	2	18.5	20.4			80	16.3					
	Fresh water pump	1	37	42.3	85	36	85	36	85	36			
	Ballast pump	1	30	32.3					85	27.5			
	AFO transfer pump	1	1.5	1.8	85	1.5			85	1.5	80	1.4	
	CFO transfer pump (Engine room)	1	2.2	2.7	85	2.3							
	L.O. transfer pump	1	0.75	0.9	80	0.7							
	Engine room bilge pump	1	0.75	0.9	85	0.75							
	Sludge pump	1	1.5	1.8									
	Purifier pump	2	2.2	2.7	80 x 2	4.3	80 x 2	4.3	80 x 2	4.3	80	2.2	
	Electric chain lock	1	1.3	1.6									
	Electric welding machine	1		28									

	Inspected Items	Electric Motor		Total Input Power (Kw)	Consumption rate（%） and Electric Power Comsumption Amount（Kw）								Remark
		Amount of Unit	Output Power (Kw)		During Sailing		During In-Out Port Proccess		During Loading and Unloading		During Anchorage		
					%	(Kw)	%	(Kw)	%	(Kw)	%	(Kw)	
continuous use items	CFO Transfer pump（bow）	1	3.7	4.3	80	3.4	80	3.4	80	3.4	80	3.4	Also function as vaporizer at the same time
	Pump room bilge pump	1	3.7	4.3					80	3.4			
	Disposer	1	1.5	1.8	80	1.4	80	1.4	80	1.4	80	1.4	
	Turning motor main engine	1	1.5	1.8									
	Stuffing box L.O. Pump	1	0.4	0.5	80	0.4							
	Ladder winch	2	1.5	1.8			80	1.4					
	Piston horn	1	5.5	6.3	80	5.3	80	5.3					
	Sewage processing unit / treatment	1	0.4	5	80	0.4							
	Soup kettle	1		6	70	4.2	70	4.2	70	4.2	70	4.2	
	Waste oil incinerator	1	1.5	1.8	80	1.4							
Required Electric Power	Intermittent used Items	Total (Kw)			107.8		118.2		168.6		63.7		
		Invalid rate (%)			65		65		65		65		
		Required electric power (Kw)			70.1		76.8		109.6		41.4		
	continuous used items	Required electric power (Kw)			188.75		266		195.3		52.1		
	Intermittent used items＋continuous used items (Kw/KVA)				258.8/323.6		342.8/428.5		304.9/381.1		93.5/116.88		
Generator Output Power（KVA) x amount（unit)					400 x 1		400 x 2		400 x 2		400 x 1		
Generator Loading Rate （%）					80		53.5		47.6		29.2		
Electrical equipment specification					AC 445 V x 3 Phase x 60 Hz x 6 P x 400 kVA								

According to these calculation items based on design, the generators have the maximum capacity of power 362.75 kVA in sailing condition, 582.7 kVA in Maneuvering condition, 683.5 kVA when the ship is in loading and discharging condition, and there is no required power in anchoring condition because of the rules.

In this case, the maximum capacity of power is 683.5 kVA when the ship is in loading/Discharging condition. The Load factor from Indonesian Shipyard (PT PAL) requirements is higher than in Design from the shipyard, so in several condition power capacity of generator is higher regarding Indonesian Shipyard (PT PAL) Requirements. But there are many different items between table of items based on Indonesian Shipyard (PT PAL) requirements and items in MT SUCCESS VICTORY XXXIV, so it uses the similarity items between Indonesian Shipyard (PT PAL) requirements and items on the ship.

Such as power pack electric motors that are not mentioned in Indonesian Shipyard (PT PAL) requirement, whereas this item has a big capacity of power to generate all of the other items to work.

Generator loading rates based on Indonesian Shipyard (PT PAL) requirements is near with Design either using Load Factor from Indonesian Shipyard (PT PAL) Requirement or from actual condition. Where based on design MT SUCCESS VICTORY XXXIV uses two generators, and based on the calculation table by Indonesian Shipyard (PT PAL) requirements this ship also uses a couple of generators to operate this ship because it has similarity load factor capacity of the generator but in Indonesian Shipyard (PT PAL) Requirements, the load factor is higher.

4.3.3 Calculation Table of Electric Power Table Based on Actual Conditions

This table calculates required electric power table based on usage of item from Actual Condition. The red marks on this table represent the items which do not use in actual condition.

Table 4. 5 Requiered Power Table based on actual condition

	Inspected Items	Electric Motor		Total Input Power (Kw)	Consumption rate（%）and Electric Power Comsumption Amount（Kw）								Remark
		Amount of Unit	Output Power (Kw)		During Sailing		During Entry-Departure Port Process		During Loading and Unloading		During Anchorage		
					%	(Kw)	%	(Kw)	%	(Kw)	%	(Kw)	
Continuous use items	Steering Machine	1	5.5	6.3	40	2.5	50	3.2					
	Power Pack Electric Motor	3	145	152.6			40 x 2	116	40 x 2	116			
	Engine room exhaust fan	1	2.2	2.7	80	2.2	80	2.2	80	2.2	80	2.2	Piority cut-off
	Butterworth pump *	1	55	57.3	80	45.8							Piority cut-off
	Gas-free Fan *	1	37	39.3	80	31.4							Piority cut-off
	Residencial Quarter Air Conditioning Unit; Compressor	1	5.5	6.3	80	5	80	5	80	5	80	5	
	Observation room	1	0.2	0.3	80	0.2	80	0.2	80	0.2	80	0.2	
	Engine room ventilator	2	7.5	8.3	80	6.6	80	6.6	80	6.6	80	6.6	
	Pump room exhaust fan	1	2.2	2.7					80	2.2			
	Main sea-water cooling pump	1	11	12.3	80	9.8	80	9.8					
	Main fresh water cooling pump	2	5.5	6.3	80	5.1	80	5.1					
	Main F.O. supply pump	2	1.5	1.9	80	1.4	80	1.4					
	Spare L.O. pump	1	18.5	20.4			65	13.3					
	Sea-water service pump	1	15	17.3	80	13.8	80	13.8	80	13.8	80	13.8	
	Sea-water cooler generator	1	5.5	6.3	80	5.1	80	5.1	80	5.1	80	5.1	
	Auxiliary blower	2	15	16.3			80	12					
	Fire extinguisher - misc. pump	1	37	40.3			75	30.2					
	Exhaust gas circulatory pump	2	2.2	2.7	80	2.2							
	Water supply machine: Sea-water cooler pump	1	5.5	6.3	80	5.1							
	Water supply machine: Vacuum pump	1	5.5	6.3	80	5.1							
	Water supply machine: Distilled water pump	1	0.75	0.9	80	0.7							
	F.O. Purrifier	2	5.5	6.3	80	4.4	80	5	80	5	80	5	
	L.O. Purrifier	1	5.5	6.3	80	5							
	Transformer（AC100 load）	3		15	40 x 3	18	50 x 3	22.5	50 x 3	22.5	35 x 3	15.8	
	Warm water circulatory pump	1	0.4	0.5	80	0.4	80	0.4	80	0.4	80	0.4	
	Power Pack Hydraulic oil pump	1	2.6	3.1			80	2.5	80	2.5			

Inspected Items		Electric Motor: Amount of Unit	Electric Motor: Output Power (Kw)	Total Input Power (Kw)	Consumption rate（%）and Electric Power Comsumption Amount（Kw）: During Sailing %	During Sailing (Kw)	During In-Out Port Proccess %	During In-Out Port Proccess (Kw)	During Loading and Unloading %	During Loading and Unloading (Kw)	During Anchorage %	During Anchorage (Kw)	Remark
Intermittent use items	ODM Sumpling pump	1	2.2	2.7	80	2.2							
	Lifesaving boat: davit	1	3.7	4.3									
	Lifesaving boat（passenger use）	1	18.5	20.3									
	Foam fire extinguishing pump	1	11	12.3									
	Waste oil tank stove	1		3									
	Cooking room fan	1	0.2	0.3	80	0.2	80	0.2	80	0.2	80	0.2	Also function as vaporizer at the same time
	Residence quarter Air Conditioning Unit; Compressor	1	15	17.3	80	13.8	80	13.8	80	13.8	80	13.8	
	Observation room	1	2.2	2.7	80	1.4	80	1.4	80	1.4	80	1.4	Priority cut-off
	Provision davit	1	1.5	1.8									
	Provisions freezer	2	3	3.3	80	2.6	80	2.6	80	2.6	80	2.6	
	Cooking range	1		19	70	13.3	70	13.3	70	13.3	70	13.3	
	Supporting Boiler: Fan	1	37	40.3	80	32.2	80	32.2	80	32.2	80	32.2	
	Supporting Boiler: F.O. Pump	1	2.2	2.7	80	2.2	80	2.2	80	2.2	80	2.2	
	Supporting Boiler: F.O. Heater			17									
	Supporting Boiler: Water supply pump	2	11	12.3	80	9.8	80	9.8	80	9.8	80	9.8	
	Supporting Boiler: waste oil pump	1	0.4	0.5									
	Calorifier	1		3									
	Main Air Compressor	2	18.5	20.4	80	16.3	80	16.3	80	16.3			
	Fresh water pump	1	37	42.3	70	29.6							
	Ballast pump	1	30	32.3					70	22.6			
	AFO transfer pump	1	1.5	1.8	80	1.4	80	1.4	80	1.4	80	1.4	
	CFO transfer pump (Engine room)	1	2.2	2.7	80	2.2							
	L.O. transfer pump	1	0.75	0.9	80	0.7							
	Engine room bilge pump	1	0.75	0.9									
	Sludge pump	1	1.5	1.8									
	Purifier pump	2	2.2	2.7	80	2.2	80	2.2	80	2.2	80	2.2	
	Electric chain lock	1	1.3	1.6									
	Electric welding machine	1		28									

	Inspected Items	Electric Motor: Amount of Unit	Electric Motor: Output Power (Kw)	Total Input Power (Kw)	Consumption rate（%）and Electric Power Comsumption Amount（Kw）: During Sailing %	During Sailing (Kw)	During In-Out Port Proccess %	During In-Out Port Proccess (Kw)	During Loading and Unloading %	During Loading and Unloading (Kw)	During Anchorage %	During Anchorage (Kw)	Remark
Continuous items use	CFO Transfer pump（bow）	1	3.7	4.3	80	3.4	80	3.4	80	3.4	80	3.4	Also function as vaporizer at the same time
	Pump room bilge pump	1	3.7	4.3					80	3.4			
	Disposer	1	1.5	1.8	80	1.4	80	1.4	80	1.4	80	1.4	
	Turning motor main engine	1	1.5	1.8									
	Stuffing box L.O. Pump	1	0.4	0.5	80	0.4							
	Ladder winch	2	1.5	1.8									
	Piston horn	1	5.5	6.3									
	Sewage processing unit / treatment	1	0.4	5	80	0.4							
	Soup kettle	1		6	70	4.2	70	4.2	70	4.2	70	4.2	
	Waste oil incinerator	1	1.5	1.8	80	1.4							
Required Electric Power	Intermittent used Items	Total (Kw)			192		80		102.72		63.7		
		Invalid rate (%)			65		65		65		65		
		Required electric power (Kw)			124.8		52		66.7		41.4		
	Continuous used items	Required electric power (Kw)			85		244.4		182.9		52.1		
	Intermittent used items＋Continuous used items (Kw/KVA)				209.8/262.25		296.4/370.5		274/342		93.5/116.88		
Generator Output Power（KVA) x amount（unit)					400 x 1		400 x 2		400 x 1		400 x 1		
Generator Loading Rate （%）					66		46.3		85.5		29.2		
Electrical equipment specification					AC 445 V x 3 Phase x 60 Hz x 6 P x 400 kVA								

According to these calculation items based on design, the generators have the maximum capacity of power 262.25 kVA in sailing condition, 370.5 kVA in Maneuvering condition, 342 kVA when the ship is in loading and discharging/discharging condition, and 116.88 in Anchoring condition.

In this case, the maximum capacity of power is 370 kVA when the ship is in sailing condition. It may possible even though based on design discharging uses the highest power capacity. So, there are different calculations between the table of items based on design, Indonesian Shipyard (PT PAL) requirements and actual condition of MT SUCCESS VICTORY XXXIV.

Based on analyzing in actual condition power pack electric motors did not use as it should be operated. Because of that, maneuvering has higher power capacity than loading/discharging condition. In loading/discharging condition power pack electric motors should use all of those items, but in actual condition, in loading/discharging and maneuvering condition the crews of ship turn on power pack electric motors only two items. In addition, because of the different climates, temperatures, weathers, sea areas and many other factors between Indonesia and Japan, crews of the ship did not use some items because that ship is not too need those items such as: Residencial Quarter Air Conditioning Unit; Compressor, Spare L.O. pump, Exhaust gas circulatory pump, Warm water circulatory pump, Cooking room fan, and other items that have mentioned by the red marks in this table. So, all of the conditions have decreasing power capacity because of items using that are not suitable for the first design in Murakami shipyard which has different factors (climates, temperatures, weathers, sea areas) for ship in Indonesia.

Generator loading rates based on actual conditions are 66% in sailing condition, 46.3% in maneuvering condition using two generators, 85.5% in loading and discharging condition, and 29.2% in anchoring condition . Assumed this ship uses the generator from Murakami shipyard, were based on design MT SUCCESS VICTORY XXXIV uses two generators, even though there are high the rest of the power capacity of the generator.

4.4 Evaluation of Generator

Final observation for this generator is comparison the generator that shows generator’s power (P) in switchboard’s panel and compares with: design, Indonesian Shipyard (PT PAL) requirement, and actual condition.

After knowing which is the closest to power on switchboard’s panel comparison, this thesis also compares load factors in every condition with switchboard’s panel and finds the closest of load factor.

4.4.1 Comparison Based on Power

this thesis will make a calculation based on the highest and the lowest power in every condition in switchboard’s panel on this ship to ensure and analyze the calculation that may closer with that three comparisons before (calculation table of electric power table based on: Design, Indonesian Shipyard (PT PAL), and actual condition). From the panel, power capacity shows in kW and it converts to KVA by times with 1.25. This data can see in Chapter of Attachment on the last page of this thesis.

kW to kVA $\longrightarrow$ x 1.25

After getting the results which are the closest power capacity between observation in Engine Control Room to see the switchboard’s panel with the calculation of electric power table, this thesis also gives a recommendation to the owner about the power capacity of generators that should be operating now.

Table 4. 6 Power Capacity Based on Switchboard’s Panel

No.	Conditions	The Highest Power	Happened on	The lowest Power	Happened on
1	Sailing	537.5 kVA	February 23 rd 2017	106.25 kVA	February 20 th 2017
2	Maneuvering	500 kVA	February 22 nd 2017	125 kVA	February 19 th 2017
3	Loading/Discharging	275 kVA	February 22 nd 2017	150 kVA	February 21 st 2017
4	Anchoring	187.5 kVA	February 27 th 2017	75 kVA	February 20 th 2017

From this table explains that based on switchboard’s panel, the highest power all of the conditions thus in Sailing condition neither in maneuvering condition nor loading/discharging condition. But if we see overall the table before, maneuvering and loading/discharging condition use high power capacity constantly.

Back to calculation table of electric power table, to match it with switchboard's panel, this thesis uses the highest power capacity by the final result of required electric power from these three comparisons (based on: Design, Indonesian Shipyard (PT PAL) Requirements, Actual Condition) to compare with switchboard's panel.

- Based on design: the highest power capacity is 712.8 kVA when the ship in Loading/Discharging condition and it compares with the highest power capacity in the panel is 537.5 kVA. There is a gap in power capacity between design and panel that has 175.3 kVA.
- Based on Indonesian Shipyard (PT PAL) Requirements: the highest power capacity is 683.5 kVA when the ship in sailing condition and it compares with the highest
  power capacity in the panel is 537.5 kVA. There is a gap in power capacity between design and panel that has 176 kVA.
- Based on Actual Condition: the highest power capacity is 370.5 kVA when the ship in maneuvering condition and it compares with the highest power capacity in the panel is 537.5 kVA. There is a gap in power capacity between design and panel that has 167.5 kVA.

After getting this information we know that power capacity showed in switchboard's panel is closer with calculation of power table based on actual condition eventough the gap is still far with existing condition in panel. But it is better than in design and Indonesian Shipyard (PT PAL) requiremets. Because in existing condition MT SUCCESS VICTORY XXXIV has couple of generators with big power capacity, it should be installed new generator with lower capacity.

4.4.2 Comparison Based on Load Factor

This thesis will make a calculation based on the highest load factor in every condition that will be divided by the maximum capacity of the generator (800 kVA). in switchboard's panel on this ship to ensure and analyze the calculation that may closer with that three comparisons before (calculation table of electric power table based on: Design, Indonesian Shipyard (PT PAL), and actual condition). The Formula of Load Factor is:

$$LF = \frac{\text{Power is using for x Condition}}{\text{Total generator(in power) for x condition}}$$

- Design from Murakami Shipyard:

  Sailing Condition:

  $LF = \frac{344.1 \text{ kVA}}{400 \text{ kVA}} = 0.43$

  Anchoring Condition:

  $LF = \frac{149.1 \text{ kVA}}{400 \text{ kVA}} = 0.373$

  Maneuvering Condition

  $LF = \frac{552.3 \text{ kVA}}{400 \text{ kVa x 2}} = 0.69$

  Loading/Discharging Condition:

  $LF = \frac{712.8 \text{ kVA}}{400 \text{ kVA X 2}} = 0.89$

- Indonesian Shipyard (PT PAL) Requirement:

  Sailing Condition:

  $LF = \frac{362.75 \text{ kVA}}{400 \text{ kVA}} = 0.90$

  Anchoring Condition:

  $LF = -$

  Maneuvering Condition

  $LF = \frac{582.7 \text{ kVA}}{400 \text{ kVa x 2}} = 0.728$

  Loading/Discharging Condition:

  $LF = \frac{683.5 \text{ kVA}}{400 \text{ kVA X 2}} = 0.85.4$

- Actual Condition:

  Sailing Condition:

  $LF = \frac{262.25 \text{ kVA}}{400 \text{ kVA}} = 0.664$

  Anchoring Condition:

  $LF = \frac{116.8 \text{ kVA}}{400 \text{ kVA}} = 0.29.2$

  Maneuvering Condition

  $LF = \frac{370.5 \text{ kVA}}{400 \text{ kVa x 2}} = 0.463$

  Loading/Discharging Condition:

  $LF = \frac{342\text{kVA}}{400 \text{ kVA}} = 0.855$

Table 4. 7 Comparison Load Factor based on Switchboard's Panel

	Sailing	Maneuvering	Loading/Discharging	Anchoring
Design (Murakami Shipyard)	22%	69%	89.10%	18.6
Indoneisan Shipyard (PT PAL)	45.00%	72.80%	85.40%	-
Actual Condition	66.40%	46.30%	42.75%	29.2
SWITCHBOARD'S PANEL	67.20%	62.50%	34.40%	23.40%
Amount of Generators	2	2	2	1

After getting this data, the conclusion is actual condition of this is the closest load factor's similarity with switchboard's panel as the concrete evidence. Design from Shipyard has two conditions that closes with panel they are on loading/discharging and maneuvering, but in sailing and anchoring condition, load factor based on actual condition is more close with the panel. So, this load factor follows the Actual Condition.

4.4.3 Final Evaluation

Based on power and load factor comparison this thesis concludes generator in actual condition is the closest with the panel, even though for Maneuvering and Loading/Discharging condition Load Factor is closer with first Design, but in power capacity, actual condition is the most similar with the panel. So this thesis uses the actual condition as the final evaluation for the generator.

The highest power of ship is 537.5 kVA in sailing condition. Because of the many different factors and condition of the generator that has already old, so This thesis assumes that maximum power capacity of the generator now 600 kVA. If generators replace, there are two choices for new generators that will be installed on MT SUCCESS VICTORY XXXIV. First, is installing three generators with 200 kVA power capacity, and second is installing new generators with power capacity are two generators with power capacity 300 kVA. And in this case, this thesis uses three generators because of new regulation about ship with Length above 100 m and to make the ship more efficient with the turn of generators for one day, so the generator which is not in its turn for operation can work better than only using two generators like now.

CHAPTER V
CONCLUSION

5.1 Conclusion

Based on observations and data analysis in Engine Control Room's MT SUCCESS VICTORY XXXIV, it can be concluded that

1. Generators on SUCCESS VICTOY XXXIV get a decreasing performance power capacity because it has been using more than 15 years. The decreasing performance of the generators is 200 kVA. And now it may possible to this ship changes its generator with lower capacity about 600 kVA.
2. Load Factor has been decreased in each condition when it compared with the first design the highest load factor in each condition are, 43% for sailing condition become 33,2%, 69% for maneuvering condition become 46,3%, 89,1% for loading/discharging condition become 42,75%, and 18,6% for anchoring condition became 14,6%
3. There are some items that do not use again in MT SUCCESS VICTORY XXXIV because of many factors such as the different climates, temperatures, weathers, sea areas.
4. This ship should be using three generators with power of capacity 200 kVA for each Generator because of new regulation about ship with Length above 100 m and to make ship more efficient with the turn of generators for one day, so the generator which is not in its turn for operation can work better than only using two generators like now.

5.2 recommendation

The recommendations from this research are:

1. there is further research to analyze fuel efficiency on the ship based on generator usage.
2. There is further research to analyze the effects of generator usage if it does not match with power capacity

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ATTACHMENT

ATTACHMENT A

The port of Gresik

In The port of Gresik, this ship discharged 4000 Tons of Methanol for one day. After discharging, this ship maneuvered out to the port and did anchoring near the port to bunker, because there is also another ship want to load or discharge in the port of Gresik. After bunkering, MT SUCCESS VICTORY XXXIV continued its trip to Probolinggo to discharge its load again.

Saturday, February 18th 2017
(Using 2 Generatos)

Discharging Generator No.1						
time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
15:00	120	190	440	60	0.828757	0.375
16:00	118	190	440	60	0.814944	0.36875
17:00	110	180	440	60	0.801899	0.34375
18:00	98	160	440	60	0.803721	0.30625
19:00	90	150	440	60	0.787319	0.28125
20:00	90	150	440	60	0.787319	0.28125
21:00	90	150	440	60	0.787319	0.28125
22:00	88	150	440	60	0.769823	0.275
23:00	88	150	440	60	0.769823	0.275
0:00	85	150	440	60	0.743579	0.265625

Discharging Generator No.2						
time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
15:00	95	190	440	60	0.656099	0.296875
16:00	95	190	440	60	0.656099	0.296875
17:00	95	200	440	60	0.623294	0.296875
18:00	95	200	440	60	0.623294	0.296875
19:00	115	210	440	60	0.718585	0.359375
20:00	110	210	440	60	0.687342	0.34375
21:00	110	210	440	60	0.687342	0.34375
22:00	85	170	440	60	0.656099	0.265625
23:00	85	170	440	60	0.656099	0.265625
0:00	79	170	440	60	0.609786	0.246875

Sunday, February 19th 2017
(Using 2 Generators)

Maneuvering Generator No.1						
time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
6:00	80	150	440	60.05	0.699839	0.25
6:25	90	150	440	60.06	0.787319	0.28125
7:00	80	150	440	60	0.699839	0.25

Maneuvering Generator No.2						
time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
6:00	80	200	440	60.05	0.524879	0.25
6:25	110	230	440	60.06	0.627573	0.34375
7:00	82	200	440	60	0.538001	0.25625

(Using 1 Generator)

Anchoring Bunker Generator No.1						
time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
8:00	100	150	440	60	0.874799	0.3125
8:10	110	160	440	60	0.902136	0.34375
9:00	80	110	440	60	0.954326	0.25
10:00	82	110	440	60	0.978184	0.25625
11:00	75	100	440	60	0.984149	0.234375
12:00	80	110	440	60	0.954326	0.25
13:00	80	105	440	60	0.99977	0.25
14:00	75	150	440	60	0.656099	0.234375
15:00	70	150	440	60	0.612359	0.21875
16:00	70	145	440	60	0.633475	0.21875
17:00	80	150	440	60	0.699839	0.25
18:00	75	140	440	60	0.702963	0.234375

(Using 2 Generators)

Maneuvering Generator No.1						
time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
18:00	63	100	440	60	0.826685	0.196875
19:00	45	80	440	60	0.738111	0.140625
19:15	100	200	440	60.05	0.656099	0.3125
19:20	120	170	440	60.06	0.926258	0.375
19:30	80	150	440	60.06	0.699839	0.25
20:00	60	100	440	60	0.787319	0.1875
21:00	60	80	440	60	0.984149	0.1875

Maneuvering Generator No.2						
time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
18:00	80	150	440	60	0.699839	0.25
19:00	80	150	440	60	0.699839	0.25
19:15	140	300	440	60.05	0.612359	0.4375
19:20	140	250	440	60.06	0.734831	0.4375
19:30	100	205	440	60.06	0.640097	0.3125
20:00	80	150	440	60	0.699839	0.25
21:00	40	120	440	60	0.437399	0.125

ATTACHMENT B

The port of Probolinggo

In this port, this ship sailed almost two days and waited for discharging for two days because there were also two ships discharging in the same port. After getting its turn to discharge, this ship discharged 2000 Tons of Methanol for one day and left this port after discharging immediately.

Sunday, February 19th 2017
(Using 1 Generator)

Sailing Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
21:00	100	170	440	60	0.771881	0.3125
22:00	100	180	440	60	0.728999	0.3125
23:00	90	180	440	60	0.656099	0.28125

Monday, February 20th 2017
(Using 1 Generator)

Sailing Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	85	150	440	60	0.743579	0.265625
1:00	85	150	440	60	0.743579	0.265625
2:00	85	150	440	60	0.743579	0.265625
3:00	85	150	440	60	0.743579	0.265625
4:00	85	150	440	60	0.743579	0.265625
5:00	110	175	440	60	0.82481	0.34375
6:00	100	170	440	60	0.771881	0.3125
7:00	100	170	440	60	0.771881	0.3125
8:00	100	170	440	60	0.771881	0.3125
9:00	110	180	440	60	0.801899	0.34375
10:00	110	180	440	60	0.801899	0.34375

(Using 2 Generatos)

Maneuvering Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
10:25	60	100	440	60	0.787319	0.1875
11:00	45	85	440	60	0.694693	0.140625
11:25	80	150	440	60	0.699839	0.25

Maneuvering Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
10:25	60	140	440	60	0.562371	0.1875
11:00	60	120	440	60	0.656099	0.1875
11:25	100	200	440	60	0.656099	0.3125

(Using 1 Generator)

Anchoring Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
12:00	100	150	440	60	0.874799	0.3125
13:00	90	150	440	60	0.787319	0.28125
14:00	90	150	440	60	0.787319	0.28125
15:00	90	150	440	60	0.787319	0.28125
16:00	90	150	440	60	0.787319	0.28125
17:00	85	150	440	60	0.743579	0.265625
18:00	80	140	440	60	0.749828	0.25
19:00	80	140	440	60	0.749828	0.25
20:00	80	140	440	60	0.749828	0.25
21:00	65	100	440	60	0.852929	0.203125
22:00	60	100	440	60	0.787319	0.1875
23:00	60	100	440	60	0.787319	0.1875

Tuesday, February 21st 2017
(Using 1 Generator)

Anchoring Generator No.1						
Time	P(Kw)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	60	100	440	60	0.787319	0.1875
1:00	60	100	440	60	0.787319	0.1875
2:00	60	100	440	60	0.787319	0.1875
3:00	60	100	440	60	0.787319	0.1875
4:00	60	100	440	60	0.787319	0.1875
5:00	85	140	440	60	0.796692	0.265625
6:00	85	140	440	60	0.796692	0.265625
7:00	85	140	440	60	0.796692	0.265625
8:00	85	140	440	60	0.796692	0.265625

Anchoring Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
8:00	80	140	440	60	0.749828	0.25
9:00	80	140	440	60	0.749828	0.25
10:00	85	140	440	60	0.796692	0.265625
11:00	85	140	440	60	0.796692	0.265625
12:00	90	150	440	60	0.787319	0.28125
13:00	100	180	440	60	0.728999	0.3125
14:00	85	150	440	60	0.743579	0.265625
15:00	80	140	440	60	0.749828	0.25
16:00	90	150	440	60	0.787319	0.28125
17:00	90	150	440	60	0.787319	0.28125
18:00	95	150	440	60	0.831059	0.296875

Discharging Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
18:45	100	150	440	60	0.874799	0.3125
18:50	60	100	440	60	0.787319	0.1875
19:00	60	100	440	60	0.787319	0.1875
19:50	85	140	440	60	0.796692	0.265625
19:55	100	160	440	60	0.820124	0.3125
20:00	120	200	440	60	0.787319	0.375
21:00	90	150	440	60	0.787319	0.28125
22:00	80	110	440	60	0.954326	0.25

Discharging Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
18:45	110	250	440	60	0.757576	0.34375
18:50	110	250	440	60	0.757576	0.34375
19:00	60	160	440	60	0.645661	0.1875
19:50	60	160	440	60	0.645661	0.1875
19:55	60	160	440	60	0.645661	0.1875
20:00	80	170	440	60	0.810241	0.25
21:00	90	200	440	60	0.774793	0.28125
22:00	60	150	440	60	0.688705	0.1875

Wednesday, February 22nd 2017
(Using 2 Generator)

Discharging Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
8:00	110	180	440	60	0.801899	0.34375
9:00	100	150	440	60	0.874799	0.3125
10:00	100	150	440	60	0.874799	0.3125
11:00	60	100	440	60	0.787319	0.1875
11:25	60	100	440	60	0.787319	0.1875

Discharging Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
8:00	110	200	440	60	0.721709	0.34375
9:00	95	200	440	60	0.623294	0.296875
10:00	100	200	440	60	0.656099	0.3125
11:00	80	170	440	60	0.617505	0.25
11:25	60	160	440	60	0.492074	0.1875

Manuvering for Sailing Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
15:40	30	70	440	60	0.562371	0.09375
16:10	60	100	440	60	0.787319	0.1875
16:25	120	200	440	60	0.787319	0.375
16:26	180	250	440	60	0.944783	0.5625
16:28	200	280	440	60	0.937284	0.625
16:29	240	320	440	60	0.984149	0.75
16:30	120	200	440	60	0.787319	0.375
16:40	85	150	440	60	0.743579	0.265625
17:00	80	150	440	60	0.699839	0.25
18:00	80	150	440	60	0.699839	0.25

Manuvering for sailing Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
15:40	100	160	440	60	0.820124	0.3125
16:10	60	150	440	60	0.524879	0.1875
16:25	80	200	440	60	0.524879	0.25
16:26	120	230	440	60	0.684625	0.375
16:28	140	250	440	60	0.734831	0.4375
16:29	160	250	440	60	0.839807	0.5
16:30	100	200	440	60	0.656099	0.3125
16:40	80	150	440	60	0.699839	0.25
17:00	80	150	440	60	0.699839	0.25
18:00	80	150	440	60	0.699839	0.25

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ATTACMENT C

The port of Bontang

In Bontang, this ship back to charge its load with full capacity. But in this case, this ship waited 4 days to charge the load because the port in this city is very busy. After charging its load with Methanol again, this ship sailed to Banten for discharging its load in 2 ports in Banten (Merak and Anyer).

Wednesday, February 22nd 2017

Sailing Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
17:40	120	200	440	60	0.787319	0.375
18:00	110	160	440	60	0.902136	0.34375
19:00	100	150	440	60	0.874799	0.3125
20:00	110	180	440	60	0.801899	0.34375
21:00	120	200	440	60	0.787319	0.375
22:00	110	170	440	60	0.849069	0.34375
23:00	110	150	440	60	0.962279	0.34375

Thrusday, February 23rd 2017

Sailing Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	110	170	440	60	0.849069	0.34375
1:00	110	170	440	60	0.849069	0.34375
2:00	110	170	440	60	0.849069	0.34375
3:00	110	170	440	60	0.849069	0.34375
4:00	110	170	440	60	0.849069	0.34375
5:00	110	170	440	60	0.849069	0.34375
6:00	110	170	440	60	0.849069	0.34375

Sailing Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
6:48	180	250	440	60	0.944783	0.5625
6:50	260	350	440	60	0.974776	0.8125
7:00	110	200	440	60	0.721709	0.34375
8:00	100	200	440	60	0.656099	0.3125
8:20	80	130	440	60	0.807507	0.25
9:00	80	130	440	60	0.807507	0.25
10:00	80	130	440	60	0.807507	0.25
11:00	80	130	440	60	0.807507	0.25
12:00	80	130	440	60	0.807507	0.25

Sailing Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
6:48	120	200	440	60	0.78731892	0.375
6:50	170	280	440	60	0.79669176	0.53125
7:00	100	170	440	60	0.77188129	0.3125
8:00	100	170	440	60	0.77188129	0.3125
8:20	100	170	440	60	0.77188129	0.3125
9:00	110	190	440	60	0.75969369	0.34375
10:00	110	190	440	60	0.75969369	0.34375
11:00	100	170	440	60	0.77188129	0.3125
12:00	60	130	440	60	0.60562994	0.1875

Sailing Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
13:00	120	200	440	60	0.78731892	0.375
14:00	120	200	440	60	0.78731892	0.375
15:00	120	200	440	60	0.78731892	0.375
16:00	120	200	440	60	0.78731892	0.375
17:00	120	200	440	60	0.78731892	0.375
18:00	120	200	440	60	0.78731892	0.375
19:00	120	200	440	60	0.78731892	0.375
20:00	120	200	440	60	0.78731892	0.375
21:00	120	200	440	60	0.78731892	0.375
22:00	120	200	440	60	0.78731892	0.375
23:00	120	200	440	60	0.78731892	0.375

Friday, February 24th 2017
(Using 1 Generator)

Sailing Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	120	200	440	60	0.787319	0.375
1:00	120	200	440	60	0.787319	0.375
2:00	120	200	440	60	0.787319	0.375
3:00	120	200	440	60	0.787319	0.375
4:00	120	200	440	60	0.787319	0.375
5:00	120	200	440	60	0.787319	0.375
6:00	120	200	440	60	0.787319	0.375
7:00	120	200	440	60	0.787319	0.375
8:00	120	200	440	60	0.787319	0.375
9:00	120	200	440	60	0.787319	0.375
10:00	120	200	440	60	0.787319	0.375
11:00	120	200	440	60	0.787319	0.375

Sailing Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
12:00	100	150	440	60	0.8747988	0.3125
13:00	140	210	440	60	0.8747988	0.4375
14:00	140	210	440	60	0.8747988	0.4375
15:00	140	210	440	60	0.8747988	0.4375
16:00	140	200	440	60	0.91853874	0.4375
17:00	120	200	440	60	0.78731892	0.375
18:00	120	200	440	60	0.78731892	0.375
19:00	120	180	440	60	0.8747988	0.375
20:00	120	180	440	60	0.8747988	0.375
21:00	120	180	440	60	0.8747988	0.375

Manuvering Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
21:15	50	80	440	60	0.820124	0.15625
21:50	120	200	440	60	0.787319	0.375
22:00	80	150	440	60	0.699839	0.25
22:10	120	200	440	60	0.787319	0.375
22:15	80	150	440	60	0.699839	0.25

Manuvering Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
21:15	75	130	440	60	0.75703742	0.234375
21:50	150	250	440	60	0.78731892	0.46875
22:00	110	200	440	60	0.72170901	0.34375
22:10	140	250	440	60	0.73483099	0.4375
22:15	80	180	440	60	0.5831992	0.25

Saturday, February 25th 2017
1 Generator

Anchoring Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	80	150	440	60	0.699839	0.25
1:00	80	150	440	60	0.699839	0.25
2:00	70	140	440	60	0.656099	0.21875
3:00	70	140	440	60	0.656099	0.21875
4:00	80	150	440	60	0.699839	0.25
5:00	80	150	440	60	0.699839	0.25
6:00	80	150	440	60	0.699839	0.25
7:00	80	150	440	60	0.699839	0.25
8:00	80	150	440	60	0.699839	0.25
9:00	80	150	440	60	0.699839	0.25
10:00	80	150	440	60	0.699839	0.25
11:00	80	150	440	60	0.699839	0.25
12:00	80	150	440	60	0.699839	0.25
13:00	90	160	440	60	0.738111	0.28125
14:00	90	160	440	60	0.738111	0.28125
15:00	90	160	440	60	0.738111	0.28125
16:00	90	160	440	60	0.738111	0.28125
17:00	90	160	440	60	0.738111	0.28125
18:00	80	150	440	60	0.699839	0.25
19:00	80	150	440	60	0.699839	0.25
20:00	80	150	440	60	0.699839	0.25
21:00	80	150	440	60	0.699839	0.25
22:00	70	150	440	60	0.612359	0.21875
23:00	70	150	440	60	0.612359	0.21875

Sunday, February 26th 2017
1 Generator

Anchoring Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	70	130	440	60	0.70656826	0.21875
1:00	70	130	440	60	0.70656826	0.21875
2:00	70	130	440	60	0.70656826	0.21875
3:00	70	130	440	60	0.70656826	0.21875
4:00	80	130	440	60	0.80750658	0.25
5:00	80	130	440	60	0.80750658	0.25
6:00	80	140	440	60	0.74982754	0.25
7:00	80	140	440	60	0.74982754	0.25
8:00	80	140	440	60	0.74982754	0.25
9:00	80	140	440	60	0.74982754	0.25
10:00	80	140	440	60	0.74982754	0.25
11:00	80	140	440	60	0.74982754	0.25
12:00	80	140	440	60	0.74982754	0.25
13:00	80	140	440	60	0.74982754	0.25
14:00	80	140	440	60	0.74982754	0.25
15:00	80	140	440	60	0.74982754	0.25
16:00	80	140	440	60	0.74982754	0.25
17:00	80	140	440	60	0.74982754	0.25
18:00	80	140	440	60	0.74982754	0.25
19:00	80	140	440	60	0.74982754	0.25
20:00	80	140	440	60	0.74982754	0.25
21:00	70	130	440	60	0.70656826	0.21875
22:00	70	130	440	60	0.70656826	0.21875
23:00	70	120	440	60	0.76544895	0.21875

Monday, February 27th 2017
(Using 2 Generator for 19:00-23:00 PM)

Anchoring Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	70	140	440	60	0.656099	0.21875
1:00	70	140	440	60	0.656099	0.21875
2:00	70	140	440	60	0.656099	0.21875
3:00	70	140	440	60	0.656099	0.21875
4:00	80	150	440	60	0.699839	0.25
5:00	80	150	440	60	0.699839	0.25
6:00	80	150	440	60	0.699839	0.25
7:00	80	150	440	60	0.699839	0.25
8:00	80	150	440	60	0.699839	0.25
9:00	80	150	440	60	0.699839	0.25
10:00	80	150	440	60	0.699839	0.25
11:00	80	150	440	60	0.699839	0.25
12:00	85	150	440	60	0.743579	0.265625
13:00	80	140	440	60	0.749828	0.25
14:00	80	150	440	60	0.699839	0.25
15:00	70	140	440	60	0.656099	0.21875
16:00	70	140	440	60	0.656099	0.21875
17:00	80	150	440	60	0.699839	0.25
18:00	85	150	440	60	0.743579	0.265625

Anchoring Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
19:00	60	90	440	60	0.8747988	0.1875
20:00	70	100	440	60	0.91853874	0.21875
21:00	60	90	440	60	0.8747988	0.1875
22:00	60	90	440	60	0.8747988	0.1875
23:00	60	90	440	60	0.8747988	0.1875

Anchoring Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
19:00	75	150	440	60	0.6560991	0.234375
20:00	80	150	440	60	0.69983904	0.25
21:00	75	150	440	60	0.6560991	0.234375
22:00	75	150	440	60	0.6560991	0.234375
23:00	75	150	440	60	0.6560991	0.234375

Tuesday, February 28th 2017
(Using 1 Generator)

Anchoring Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	80	150	440	60	0.699839	0.25
1:00	80	150	440	60	0.699839	0.25
2:00	80	150	440	60	0.699839	0.25
3:00	80	150	440	60	0.699839	0.25
4:00	90	150	440	60	0.787319	0.28125
5:00	90	150	440	60	0.787319	0.28125
6:00	90	150	440	60	0.787319	0.28125
7:00	90	150	440	60	0.787319	0.28125
8:00	90	150	440	60	0.787319	0.28125
9:00	90	150	440	60	0.787319	0.28125
10:00	90	150	440	60	0.787319	0.28125
11:00	90	150	440	60	0.787319	0.28125

Anchoring Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
12:00	100	150	440	60	0.8747988	0.3125
13:00	90	150	440	60	0.78731892	0.28125
14:00	90	150	440	60	0.78731892	0.28125
15:00	90	150	440	60	0.78731892	0.28125
16:00	90	150	440	60	0.78731892	0.28125
17:00	85	150	440	60	0.74357898	0.265625
18:00	80	110	440	60	0.95432596	0.25
19:00	80	110	440	60	0.95432596	0.25
20:00	80	100	440	60	1.04975856	0.25
21:00	65	100	440	60	0.85292883	0.203125
22:00	60	100	440	60	0.78731892	0.1875
23:00	60	100	440	60	0.78731892	0.1875

Wednesday, March 1st 2017

Anchoring Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	60	100	440	60	0.787319	0.1875
1:00	60	100	440	60	0.787319	0.1875
2:00	60	100	440	60	0.787319	0.1875
3:00	60	100	440	60	0.787319	0.1875
4:00	60	100	440	60	0.787319	0.1875
5:00	85	140	440	60	0.796692	0.265625
6:00	85	140	440	60	0.796692	0.265625
7:00	85	140	440	60	0.796692	0.265625
8:00	85	140	440	60	0.796692	0.265625
9:00	85	140	440	60	0.796692	0.265625
10:00	85	140	440	60	0.796692	0.265625
11:00	85	140	440	60	0.796692	0.265625

Maneuvering to the Port Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
14:30	50	100	440	60	0.656099	0.15625
15:00	60	100	440	60	0.787319	0.1875
15:50	80	130	440	60	0.807507	0.25
15:55	120	210	440	60	0.749828	0.375
16:00	90	180	440	60	0.656099	0.28125
17:00	80	120	440	60	0.874799	0.25
18:00	80	120	440	60	0.874799	0.25

Maneuvering to the port Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
14:30	60	130	440	60	0.60562994	0.1875
15:00	80	150	440	60	0.69983904	0.25
15:50	100	240	440	60	0.54674925	0.3125
15:55	120	250	440	60	0.62985513	0.375
16:00	90	220	440	60	0.53680835	0.28125
17:00	80	150	440	60	0.69983904	0.25
18:00	80	150	440	60	0.69983904	0.25

Loading Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
19:00	90	150	440	60	0.787319	0.28125
20:00	100	150	440	60	0.874799	0.3125
21:00	100	150	440	60	0.874799	0.3125
22:00	100	150	440	60	0.874799	0.3125
23:00	100	150	440	60	0.874799	0.3125

Thrusday, March 2nd 2017
(Using 1 Generator)

Loading Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	100	150	440	60	0.874799	0.3125
1:00	100	150	440	60	0.874799	0.3125
2:00	100	150	440	60	0.874799	0.3125
3:00	100	150	440	60	0.874799	0.3125
4:00	110	150	440	60	0.962279	0.34375
5:00	110	150	440	60	0.962279	0.34375
6:00	110	150	440	60	0.962279	0.34375
7:00	110	150	440	60	0.962279	0.34375
8:00	110	150	440	60	0.962279	0.34375
9:00	110	150	440	60	0.962279	0.34375
10:00	100	150	440	60	0.874799	0.3125
11:00	90	150	440	60	0.787319	0.28125

Loading Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	CosPhi	Lf
12:00	80	150	440	60	0.69983904	0.25
13:00	80	150	440	60	0.69983904	0.25
14:00	80	150	440	60	0.69983904	0.25
15:00	80	150	440	60	0.69983904	0.25

Maneuvering Out to Port Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
15:15	80	140	440	60	0.749828	0.25
16:00	80	140	440	60	0.749828	0.25
16:15	100	210	440	60	0.624856	0.3125
16:30	80	150	440	60	0.699839	0.25
17:00	80	150	440	60	0.699839	0.25
17:15	50	80	440	60	0.820124	0.15625
18:00	50	80	440	60	0.820124	0.15625

Maneuvering Out to Port Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
15:15	80	150	440	60	0.69983904	0.25
16:00	80	150	440	60	0.69983904	0.25
16:15	160	250	440	60	0.83980684	0.5
16:30	85	200	440	60	0.55768423	0.265625
17:00	85	200	440	60	0.55768423	0.265625
17:15	50	110	440	60	0.59645372	0.15625
18:00	50	110	440	60	0.59645372	0.15625

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ATTACHMENT D

The port of Merak

Merak was the last destination of this observations. This thesis did not note all of the activity in Merak, because its data has completed. So, in Merak just only noted about this ship in sailing and maneuvering condition.

Thrusday, March 2nd 2017

Sailing Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
19:00	100	170	440	440	0.771881	0.3125
20:00	100	170	440	440	0.771881	0.3125
21:00	100	170	440	440	0.771881	0.3125
22:00	100	170	440	440	0.771881	0.3125
23:00	100	170	440	440	0.771881	0.3125

Friday, March 3rd 2017
(Using 1 Generator)

Sailing Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	100	170	440	60	0.771881	0.3125
1:00	100	170	440	60	0.771881	0.3125
2:00	100	170	440	60	0.771881	0.3125
3:00	100	170	440	60	0.771881	0.3125
4:00	100	170	440	60	0.771881	0.3125
5:00	100	170	440	60	0.771881	0.3125
6:00	110	180	440	60	0.801899	0.34375
7:00	110	180	440	60	0.801899	0.34375
8:00	110	180	440	60	0.801899	0.34375
9:00	110	180	440	60	0.801899	0.34375
10:00	100	170	440	60	0.771881	0.3125
11:00	100	170	440	60	0.771881	0.3125

Sailing Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
12:00	100	150	440	60	0.874799	0.3125
13:00	100	150	440	60	0.874799	0.3125
14:00	100	150	440	60	0.874799	0.3125
15:00	110	150	440	60	0.962279	0.34375
16:00	110	150	440	60	0.962279	0.34375
17:00	110	150	440	60	0.962279	0.34375
18:00	110	150	440	60	0.962279	0.34375
19:00	110	150	440	60	0.962279	0.34375
20:00	110	150	440	60	0.962279	0.34375
21:00	100	150	440	60	0.874799	0.3125
22:00	100	150	440	60	0.874799	0.3125
23:00	100	150	440	60	0.874799	0.3125

Saturday, March 4th 2017
(Using 1 Generator)

Sailing Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	90	140	440	60	0.843556	0.28125
1:00	90	140	440	60	0.843556	0.28125
2:00	90	140	440	60	0.843556	0.28125
3:00	90	140	440	60	0.843556	0.28125
4:00	90	140	440	60	0.843556	0.28125
5:00	90	140	440	60	0.843556	0.28125
6:00	100	150	440	60	0.874799	0.3125
7:00	100	150	440	60	0.874799	0.3125
8:00	110	150	440	60	0.962279	0.34375
9:00	110	150	440	60	0.962279	0.34375
10:00	100	150	440	60	0.874799	0.3125
11:00	100	150	440	60	0.874799	0.3125

Sailing Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
12:00	90	150	440	60	0.787319	0.28125
13:00	90	150	440	60	0.787319	0.28125
14:00	90	150	440	60	0.787319	0.28125
15:00	90	150	440	60	0.787319	0.28125
16:00	100	170	440	60	0.771881	0.3125
17:00	100	170	440	60	0.771881	0.3125
18:00	100	170	440	60	0.771881	0.3125
19:00	100	170	440	60	0.771881	0.3125
20:00	100	170	440	60	0.771881	0.3125
21:00	100	170	440	60	0.771881	0.3125
22:00	100	170	440	60	0.771881	0.3125
23:00	100	170	440	60	0.771881	0.3125

Sunday, March 5th 2017
(Using 1 Generator)

Sailing Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
0:00	90	150	440	60	0.787319	0.28125
1:00	90	150	440	60	0.787319	0.28125
2:00	90	150	440	60	0.787319	0.28125
3:00	90	150	440	60	0.787319	0.28125
4:00	90	150	440	60	0.787319	0.28125
5:00	90	150	440	60	0.787319	0.28125
6:00	90	150	440	60	0.787319	0.28125
7:00	90	150	440	60	0.787319	0.28125
8:00	90	150	440	60	0.787319	0.28125
9:00	90	150	440	60	0.787319	0.28125
10:00	100	150	440	60	0.874799	0.3125
11:00	100	150	440	60	0.874799	0.3125

Sailing Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
12:00	90	140	440	60	0.843556	0.28125
13:00	90	140	440	60	0.843556	0.28125
14:00	90	140	440	60	0.843556	0.28125
15:00	100	150	440	60	0.874799	0.3125
16:00	100	150	440	60	0.874799	0.3125
17:00	100	150	440	60	0.874799	0.3125
18:00	100	150	440	60	0.874799	0.3125
19:00	100	150	440	60	0.874799	0.3125
20:00	100	150	440	60	0.874799	0.3125
21:00	90	140	440	60	0.843556	0.28125
22:00	90	140	440	60	0.843556	0.28125
23:00	90	140	440	60	0.843556	0.28125

Monday, March 6th 2017
(Using 2 Generators)

Manuvering Generator No.1						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
8:10	60	80	440	60	0.984149	0.1875
8:23	70	110	440	60	0.835035	0.21875
8:28	100	150	440	60	0.874799	0.3125
8:30	80	140	440	60	0.749828	0.25
9:00	120	180	440	60	0.874799	0.375
9:17	80	130	440	60	0.807507	0.25
10:30	80	130	440	60	0.807507	0.25

Manuvering Generator No.2						
Time	P(kW)	I(A)	V(v)	f(Hz)	Cos Phi	Lf
8:10	65	140	440	60	0.609235	0.203125
8:23	80	165	440	60	0.636217	0.25
8:28	140	220	440	60	0.835035	0.4375
8:30	100	195	440	60	0.672922	0.3125
9:00	160	250	440	60	0.839807	0.5
9:17	80	150	440	60	0.699839	0.25
10:30	80	150	440	60	0.699839	0.25

WRITER PROFILE

The writer named Hikari Qurrata'ain Nurhadi was born in Tangerang, May 2nd 1995. The writer studied elementary school at SDIT Asy-Syukriyyah Tangerang, junior high school at SMPI Nurul Fikri Boarding School Anyer and senior high school at SMAN 5 Kota Tangerang. Then the writer continues the education at Department of Marine Engineering Double Degree, Institut Teknologi Sepuluh Nopember-Hochschule Wismar in 2013. During college, the writer gets part of KANS JATIM, Marine Innovation and Technology Club (METIC), and Lembaga Dakwah Jurusan (LDJ) at Department of Marine Engineering ITS. At the 3rd year of study, the writer joined Marine Electrical and Automatical System (MEAS) Laboratory and finished the study for an 8th semester.